JANUARY
1952

RADIO & TELEVISION NEWS

HIGH-SPEED TANDEM WINDING MACHINES

One of the many new machines that makes possible mass-production of uniform condensers *(SEE PAGE 45).*

THE QUALITY OF **RCA** TUBES IS UNQUESTIONED

Extra Performance

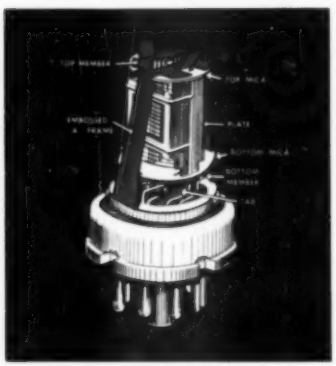
as a matter of course . . . with RCA tubes

The RCA-developed "A" frame construction—used in 6 of the metal-type r-f amplifiers—is one of the many improvements that contribute to the *extra* performance of RCA tubes.

The "A" frame—shown in red—consists of a top member, two vertical members, and a bottom cross member. The ribbed uprights are welded to the cross member . . . the feet of the uprights are welded to the grounded metal header. In effect a truss, this rigid "A" frame acts as the supporting member for the tube elements. Its increased resistance to vibration reduces the possibility of electrode displacement due to wear on the holes in the mica spacers . . . and thereby plays an important role in reducing microphonics and maintaining uniform tube characteristics.

In addition to imparting rigidity to the tube elements, the top and bottom members of the "A" frame serve as shields. The two ears on the top member add to its effectiveness in reducing grid-to-plate capacitance . . . the tab on the lower member—which extends down to the stem—provides additional shielding between grid and plate leads.

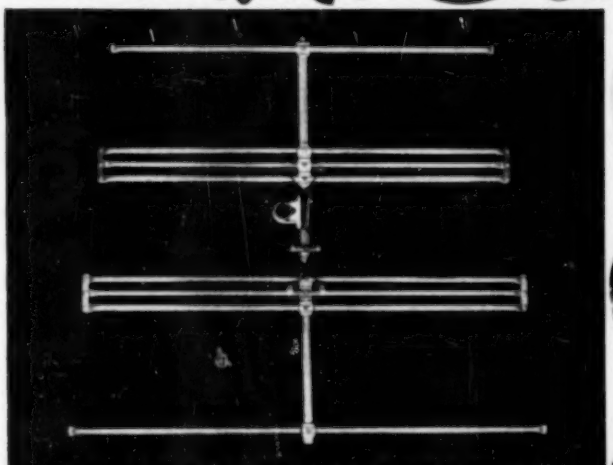
The *extra* performance built into RCA tubes accounts for their high quality, long life, and dependability. They cost no more. Why not use them for your daily tube requirements?



Keep informed—keep in touch with your RCA Tube Distributor

RADIO CORPORATION of AMERICA
ELECTRON TUBES — HARRISON, N. J.

There's No Comparison!



THE TRIO 2-CHANNEL YAGI FULL 10 DB GAIN ON TWO CHANNELS
MODEL 445 FOR CHANNELS 4 AND 5
MODEL 479 FOR CHANNELS 7 AND 9
Patent pending – no licensing arrangements granted for duplicating principle of this antenna

Yagi elements of .035" thick seamless aluminum, are full ½" in diameter. Ends are crimped for greater strength and to cut down vibration. Prevents entrance of dirt and moisture.

An extra clamping member permits taking up bolts tight without putting undue strain on element. Cast aluminum V block assures perfect right angle alignment. No detail of design or construction has been overlooked to make the TRIO 2-Channel Yagi the finest fringe area TV antenna available anywhere – at any price!

Double-folded dipole sections have heavy gauge aluminum brace bars securely rivited to element ends thus providing positive electrical connection and extreme rigidity. Workmanship throughout is of the highest order.

TRIO- the Original 2-CHANNEL YAGI

TOPS ALL IN DESIGN, CONSTRUCTION, PERFORMANCE

One of the most widely imitated antennas on the market today, the TRIO 2-Channel Yagi still stands alone in efficiency and strength.

TV buyers – and sellers – are discovering that "look alike" is not enough – that imitations are *never* as good as the original.

There is no secret to TRIO's marked superiority. The simple truth is that TRIO slights no construction detail, overlooks no design feature. This means unparalleled efficiency – rugged dependability for both installer and TV set owner.

Installers! Avoid profit eating call-backs caused by poorly made imitations! Set owners! Enjoy years of dependable, efficient TV reception! Compare the TRIO 2-Channel Yagi with any other TV antenna at any price. Yes, compare – then you, too, will insist on an original TRIO – the 2-Channel Yagi that set the standards.

TRIO the "Trouble-proof" TV Rotator

For years of dependable, unfailing service – in good weather and bad – you can't beat the new TRIO TV Rotator and Direction Indicator.

Sturdy and completely weatherproof, the TRIO Rotator will support the heaviest TV arrays – even in 80 MPH winds! Its sound design and construction has been proven by 3 years of extensive field testing under every extreme of weather. The TRIO Rotator will not freeze up!

2 HEAVY DUTY MOTORS

Two separate 24 volt motors are used – one for each direction of rotation. Thus, each motor operates just 50% of the time – cannot burn out. Positive acting electrical stops at both ends of 360° turn eliminates lead damage.

Housing is die-cast aluminum for greater strength, lighter weight and perfect alignment of parts. The TRIO Rotator is precision built throughout.

The TRIO Direction Indicator is housed in a sturdy plastic cabinet of graceful lines. It is a beautiful instrument that will blend harmoniously with any furniture style.

Utmost ease in selecting the desired antenna direction is provided by a new "finger-tip" control that operates at a light touch and the easy-to-read dial face that clearly and instantly indicates the exact antenna position.

Trio MANUFACTURING COMPANY
GRIGGSVILLE, ILLINOIS

COVER PHOTO: A high-speed tandem paper condenser winding machine in use at the Pyramid Electric Co. factory. Such units insure uniformity and help to cut production costs. (Extachrome by Jay Seymour)

First in radio-television-electronics
Average Paid Circulation over 200,000

RADIO & TELEVISION NEWS

Reg. U.S. Pat. Off.

Radio News Trademark Reg. U. S. Pat. Office ● Television News Trademark Reg. U.S. Pat. Office

CONTENTS — JANUARY, 1952

DEPARTMENTS

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NOW... GET EVERYTHING YOU NEED TO LEARN AND MASTER

TELEVISION

RADIO-ELECTRONICS ...AT HOME!

Use REAL commercial-type equipment to get practical experience

Your future deserves and needs every advantage you can give it! That's why you owe it to yourself to find out about one of the most COMPLETE, practical and effective ways now available to prepare AT HOME for America's billion dollar opportunity field of TELEVISION-RADIO-ELECTRONICS. See how you may get and keep the same type of basic training equipment used in one of the nation's finest training laboratories . . how you may get real STARTING HELP toward a good job or your own business in Television-Radio-Electronics. Mail the coupon today for complete facts — including 89 ways to earn money in this thrilling, newer field.

ABOVE: Build and keep a real 17 INCH commercial TV receiver. Optional after completing regular training at moderate added cost.

D.T.I., ALONE, INCLUDES BOTH MOVIES and HOME LABORATORY

In addition to easy-to-read lessons, you get the use of HOME MOVIES — an outstanding training advantage — plus 16 big shipments of Electronic parts. Perform over 300 fascinating experiments for practical experience. Build and keep real commercial-type test equipment shown at right

Get BOTH of these information packed publications FREE!

MODERN LABORATORIES

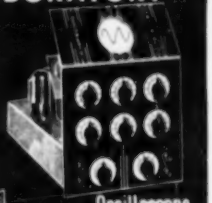
If you prefer, get all your preparation in our new Chicago Training Laboratories—one of the finest of its kind. Ample instructors, modern equipment. Write for details!

MILITARY SERVICE!

If you're subject to military service, the information we have for you should prove very helpful. Mail coupon today.

Here's the REAL THING! SET UP YOUR OWN HOME LABORATORY


R-F Signal Generator


Oscilloscope


Multimeter

ACT NOW! MAIL COUPON TODAY!

DE FOREST'S TRAINING, INC. Dept. RN-1-I
2533 N. Ashland Ave., Chicago 14, Ill.

Without obligation, I would like your Opportunity News Bulletin showing "89 Ways to Earn Money in Television-Radio-Electronics"; also, the folder showing how I may prepare to get started in this thrilling field.

Age.....

Name.....Apt.....

Address.....Zone.....State.....

City.....

"ONE OF AMERICA'S FOREMOST TELEVISION TRAINING CENTERS"

De FOREST'S TRAINING, INC.

CHICAGO 14, ILLINOIS

A DeVRY INSTITUTION

Service Clinic!

Engineering information to help you better service Raytheon

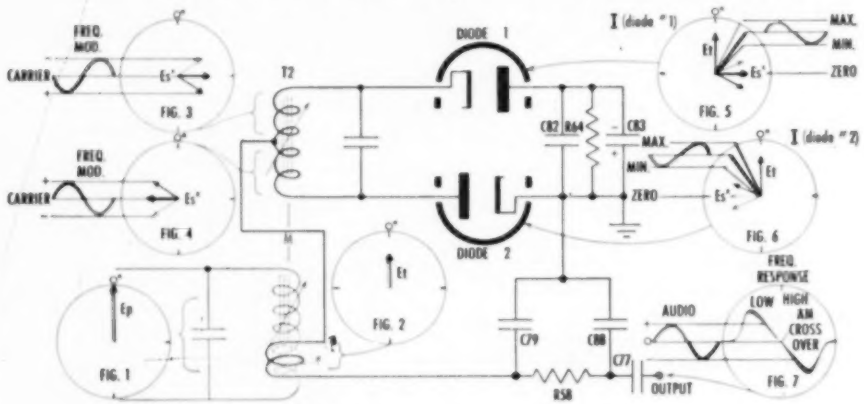
THE RATIO DETECTOR

The ratio detector is used to detect frequency modulation and reject amplitude modulation. The improved A.M. rejection of this type of detector requires less stages of limiting in the sound I.F. amplifier.

The circuit of the ratio detector illustrated uses a 6AL5 (or 6T8 etc.) duo-diode, that has balanced capacitance and perveance, and is tuned to the TV intercarrier frequency of 4.5 megacycles.

The 4.5 M.C. sound I.F. provides the input to the resonant primary of T2 (Ep of Fig. 1) which will induce a voltage across the tertiary winding (Et of Fig. 2) that will for vector study be referred to as zero degrees.

The primary will also induce a voltage into the resonant secondary through the loose coupling mutual of M so as to provide approx. 90° phase shift. The secondary will furnish two voltages of opposite (180°) polarity with respect to the center tap. These voltages (Fig. 3 and Fig. 4) will shift in phase angle with frequency modulation of the carrier due to off resonance leading or lagging reactance.



The center tapped secondary is connected to the diodes in a manner such as to place the tertiary in series with each half of the secondary. This will vectorially add the voltages Es and Et to change the diode current balance as shown in Fig. 5 and Fig. 6 when frequency modulation exists.

However, amplitude modulation does not disturb the balance and will be load limited by the shorting action of the diodes per the time-constant of R64, C82, and C83 lytic. Only the unbalanced FM currents will appear across C79 (R.F. bypass) and into the R58—C88 de-emphasis filter to produce the audio output resulting from the response curve as shown in Fig. 7. The tuning of the T2 secondary and the value of C79, effect the AM rejection cross-over point illust. in Fig. 7.

Improved circuitry such as this is one of many reasons why you can feel free to recommend Raytheon TV to a friend or customer.

Raytheon TV Presents JOHN CAMERON SWAYZE Sundays on NBC. See local paper for time and station.

"OUR FASTEST SELLING SPEAKER LINE FOR THE PAST 7 YEARS!"

Quality Product Plus Smart Promotion Spell Success for Aggressive Parts Jobber

"My dealer customers don't bother to open the cartons – as they do with other brands – before buying G-E speakers. They know that General Electric factory-packed Alnico units come to them in perfect shape, ready for use. Customer confidence pays off. Because I stock all 27 G-E models, my dealers know I can fill any speaker need."

What Dave Marks does not mention is that his merchandising skill has made him one of the top parts distributors in the East. He makes frequent and profitable use of all G-E sales tools: catalogs, booklets, envelope stuffers, display pieces of all kinds. They're available to you, too, through your General Electric distributor or representative. Call him today for your share of these sales helps.

Drive-In Theatre Speaker Sales Hot! With G.E.'s special weather-tested outdoor speaker, Dave Marks, shown here with general manager Ted Sharaf, has increased his drive-in business four times over in two years!

DEALERS AND SERVICEMEN

Here's a complete new service manual on all General Electric television receivers – 102 models manufactured since 1945! You get 80 pages packed with circuit diagrams, symbols and numbers, tube locations, top and bottom chassis views. Plus photographs and lists of service aids. Mail coupon for it today. Only $1.00.

General Electric Company, Section 912
Electronics Park, Syracuse, New York

Send me _____ copies of the new 80-page service manual on General Electric TV receivers at $1.00 each. I enclose $ _____

☐ Check ☐ Money Order

NAME _____

ADDRESS _____

CITY _____ STATE _____

GENERAL ELECTRIC

For the RECORD.

● BY THE EDITOR

TELEVISION SERVICE MATURES

ONE year ago in this column we predicted, "The year, 1951, finds the entire television industry facing severe curtailments in production as the result of our defense program and the scarcity of cobalt, aluminum and other materials and components. This curtailment of production is another real reason for sitting tight until Industry can come up with a compatible television system. As a matter of fact, this period of shortages might actually force the FCC and the Industry to shelve immediate plans for color television." Now, because of Charles Wilson's action to put the brake on commercial color television, we can, at least for the present time, direct our attention to other and equally serious television problems.

The beginning of the year 1952 finds the television industry beset with "inventory difficulties" at a time when material shortages are supposedly restricting new set production. Why then, should there be a fearful inventory condition at both manufacturing and dealer levels when we've been told, sets will soon be in short supply?

The answer undoubtedly lies in the need of both the producer and the seller for immediate capital if they are to look forward to a profitable future. The situation is a dangerous one in that a great deal of capital is tied up in warehouse stock by both the dealer and the manufacturer. The future can hold a frightful condition in which the manufacturer unloads large inventories to well-financed dealers and thus undersells the whole market, thereby placing the average dealer in an untenable position.

Considering the problem as it exists, there is certainly a need for a greater selling of television as a medium since approximately only 40% of the television market is sold. Radical corrective measures are necessary in the TV industry, from the telecaster to the dealer.

The one basic factor in this whole TV picture that has not been too "polluted" by outrageous underselling has been Service. To read the set manufacturer's advertising on both the local and the national basis, we can only come to the conclusion that the biggest difference between a good set and a bad set is the service involved. More and more manufacturers are becoming inclined to place the sale of the service contract as an adjunct to the sale of the set. Thus the service dealer finds himself in an enviable position for he, in most cases, is becoming the medium for the sale.

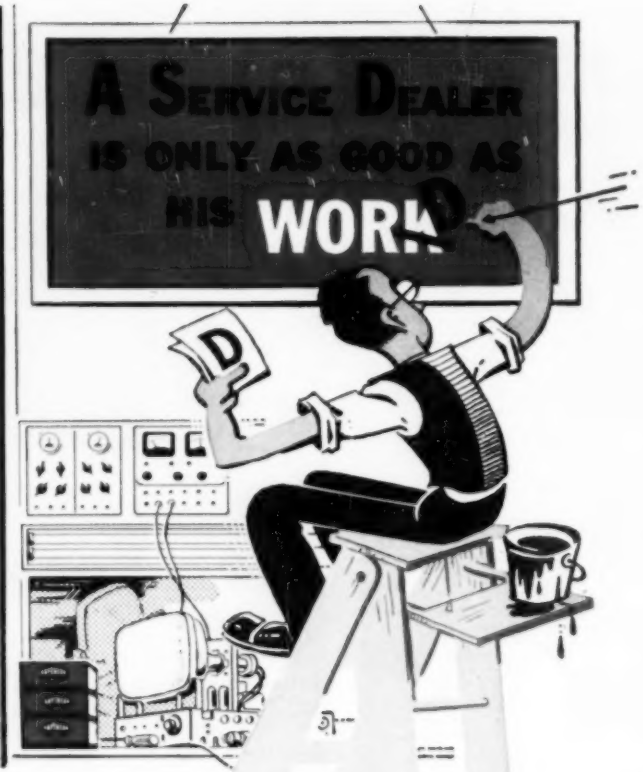
There is a pitfall that lies ahead, of which the serviceman should be cognizant. The pitfall is "priced-service." It is generally recognized today that one of the greatest deterrents to successful selling has been the sale of television receivers below cost. The situation has become so bad that the only profit margin available to the dealer in the sale of a set is the sale of a service contract. Let the serviceman not find himself in the same disreputable position. Since the consumer values service so highly, service should not be sold except as a fair price. To commit yourself to the sale of "priced-service" now would be suicidal to yourself and to the industry in the future.

In the past few months, many manufacturers have announced price reductions in all or part of their line. In some cases these price reductions have been offset by excessive charges for the parts warranty. The cost of a parts warranty should not exceed that of the expected expense in supplying new parts to replace those which may prove defective.

At least one manufacturer has recognized this problem and has included the cost of the warranty in the price of the receiver, avoiding any possibility of misrepresentation.

The increased importance of service has been recognized by the set manufacturers in the appointment of a "service coordinator" by the RTMA. There were undoubtedly many reasons for this appointment; outstanding of which was the acknowledgment that the consumer was being swayed by the importance of reliable service in the purchase of a television receiver. In some respects the coordinating job revolved about the development of a sound public relations program to make the consumer aware of the television service available. The more quickly the industry can resolve the issues with service, the more quickly a coordinated sales and service program can be established.

During the past year great strides have been made by local service organizations to not only place their establishments on a firmer footing but also to make the consumer aware of the importance of good television service. The forward progress of local associations is advancing the day when the service industry will be represented by one spokesman. When the national association comes into being, service will then be able to promote its program more thoroughly and place itself on an equal footing with sales . . . . . O.R.



Today's wary customers are more interested in the *business ethics* of a Television and Radio Service Dealer than they are in his *technical ability.*

They look for a Service Dealer who will treat them fairly, a Service Dealer whose guarantee is sound, and then take it for granted that the results will be satisfactory.

The RAYTHEON *Bonded* Electronic Technician Program gives customers just what they are looking for. If you can qualify as a Raytheon *Bonded* Electronic Technician your 90-day guarantee on service and parts is cash-protected by a *bond* issued by the American Mutual Liability Insurance Company. You are presented with a Registered Bond Certificate, Creed Displays and Identification Cards all featuring an 8-point Code of Ethics that will convince the most skeptical customers of your integrity and ability.

Back up your business with the Raytheon *Bond.* Ask your Raytheon Tube Distributor if you qualify for this exclusive business asset. It's yours *at no cost,* if you can.

RIGHT...FOR SOUND AND SIGHT©

RAYTHEON

RAYTHEON MANUFACTURING COMPANY

Receiving Tube Division

Newton, Mass., Chicago, Ill., Atlanta, Ga., Los Angeles, Calif.

Excellence in Electronics

TRAIN for Security! Good-Paying Jobs!

MAKE THE MONEY YOU'VE ALWAYS DREAMED OF!

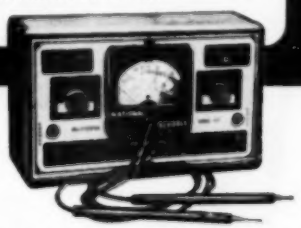
LEARN RADIO -TELEVISION

AND ELECTRONICS BY EASY SHOP METHOD TRAINING AT HOME!

You get all the parts—even tubes!—for this modern Superheterodyne Receiver. You learn to build it step by step. And you keep it! Get all the facts. Mail coupon now.

Let NATIONAL SCHOOLS—a resident-training school for nearly 50 years—train you at home for today's unlimited opportunities in Radio-Television-Electronics. National Schools is one of the largest schools of its kind. It is located in Los Angeles—the center of Radio and TV world! It has four large buildings of modern shops and labs. Its faculty is considered tops in the business.

You learn from lessons prepared by experienced instructors and engineers. Men who are successful Radio and Television technicians. Men who have trained 1000's of men like YOU!



FREE BOOK

TELLS YOU HOW!

Page after page—in *color*—tells you everything you want to know. Mail the coupon. Get this valuable book today. And if you hurry—YOU GET A FREE SAMPLE LESSON, TOO! Shows how easy National Schools Home Training is. Mail the coupon today.

You Train At Home—In Your Spare Time

National Schools Shop Method Home Training gives you basic and advanced instruction in *all* phases of Radio-TV-Electronics. And remember—your training is based on resident school training principles. You learn *fast* from hundreds of diagrams and pictures. All instructions are written by experienced technicians who work in Radio and TV every day. All instructions have been developed and tested in National Schools' own labs and studios, which are equipped with the latest RCA equipment. No wonder this National Schools course is so up-to-date, practical, interesting. And so easy to learn! And no wonder it is held in such high regard by leaders of American industry! Approved for eligible Veterans.

We Teach You How To Make Welcome Extra Money—While You Learn!

Many National Schools students—men like you—make plenty of extra dollars each week in spare time! Fixing neighbors' radios, appliances—and other ways we teach you. You start learning and earning from the day you enroll. From the very first lesson!

Only National Schools Gives You This Professional Multi-Tester!

You get this amazing, new testing instrument—factory-made and tested—complete—ready to use! Simple to operate. Accurate and dependable. An instrument every Radio-TV man needs. Light enough to carry around—so you can use it at home or on service calls. You'll be proud to own this valuable equipment.

Here are only a Few of the Good-Paying Jobs You Can Choose

Radio Station Engineer, District Service Manager, Aircraft Radio Inspector, Own Your Own Repair Shop, Inspector Technician, Service Specialist, Special Government Jobs, Complete TV Service, Sound Truck Operator, Many more!

National Schools graduates have secure, good-paying jobs like these! So don't wait—mail the coupon today. Now—while you're thinking about it!

WE SEND YOU LOTS OF PARTS LIKE THIS!

With National Schools Shop Method Home Training, you get basic principles and plenty of *practical* training. *You learn by doing.* No wonder you learn so fast! We send you many parts—all of professional, modern quality. You do lots of practical experiments. You advance day by day, step by step. Until you can even build the modern Superheterodyne Receiver you see above—plus other important testing units. The free book tells you all about it. The free sample lesson shows how easy the training is. Use the coupon. Send today — without fail!

Today's Shortage of Trained Technicians Creates Chance of a Lifetime For You!

Think of it! With guided missiles, radar, and other electronic devices so important to national defense! With big, new developments in TV. With over 90,000,000 home and auto radios, over 12,000,000 TV sets. With more than 3100 radio stations...over 100 TV stations—and more building every day...yes, imagine the great opportunity you have today!

YOU are wanted in Radio-Television-Electronics! America's fastest-growing field. High-pay jobs—the kind you've always wanted—are waiting for YOU!

Job Security! Big Money! For YOU! in Today's Expanding Industries!

Trained Radio and Television technicians really make important money these days. Thousands of National Schools graduates—men just like you—are earning good money all over the country. Why not you? And—National Schools graduates get the personal satisfaction of being highly-skilled technicians. Men people respect. Men who *enjoy* their work—rather than having to drag along in just any old job.

National Schools Has Trained 1000's of Successful Men! Why Not YOU?

In almost every state—and many foreign countries—National Schools graduates are filling big jobs with famous companies. Or running their own successful businesses. What are YOU waiting for? National Schools training is *complete* training. So when you graduate you can take advantage of today's big opportunities in Radio-Television-Electronics—fast.

Attention! Men Going into Service Soon!

National Schools' course quickly prepares you for many important jobs in the Armed Services. With National Schools Training you have an opportunity to get into *special* service classifications—with higher pay and grade—immediately!

FREE SERVICE FOR GRADUATES

National Schools uses its great influence and prestige to help you find your place in the field of your choice. Don't put it off! Start yourself toward a skilled trade! Get the big pay you've always wanted!

NATIONAL SCHOOLS

LOS ANGELES 37, CALIFORNIA • ESTABLISHED 1905

DON'T PUT IT OFF! GET THE BIG SALARY YOU HAVE ALWAYS WANTED!

MAIL THIS COUPON TODAY—WITHOUT FAIL!

NATIONAL SCHOOLS, Dept. NR-12
4000 South Figueroa Street
Los Angeles 37, California

Mail in envelope or paste on penny post card.

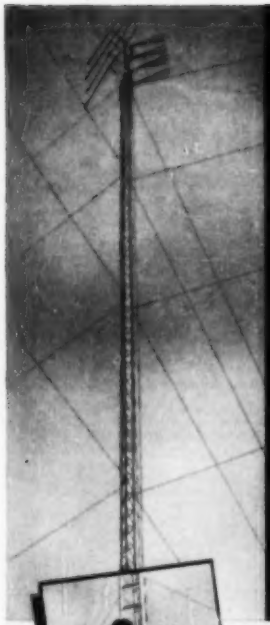
Mail me FREE the book mentioned in this ad. Also a free sample lesson. I understand no salesman will call on me.

NAME _____ AGE _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

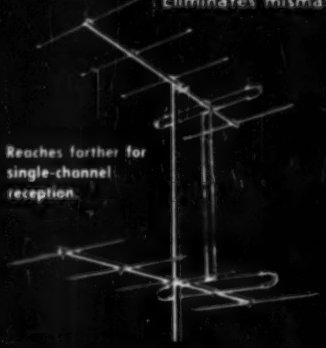
☐ Check here if you were released from the Service less than 4 years ago.



Eliminates mismatch! Outperforms standard Yagis!

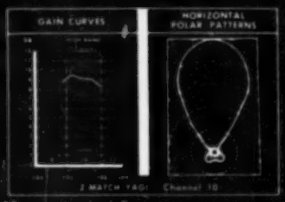
Z-MATCH YAGI*

600 Series



Reaches farther for single-channel reception.

- Perfect match to 300 ohm line, single or stacked.
- Wider spaced elements for higher gain.
- 100% gain in stacking!
- Completely preassembled.



*Patent Applied For

How The Z-Match Yagi Works

When antennas are stacked, the center feed bars of the folded dipoles are removed, automatically creating a perfect 300 ohm match for the entire stacked Yagi array. These same center bars are then used as half-wave connecting rods. This means

YOU DON'T PAY FOR STACKING BARS!

developed by

CHANNEL MASTER

FIRST IN PREASSEMBLED ANTENNAS

For "Far Reaching" Results

new!

TOWERS

by Channel Master

- Steel tubular uprights.
- Built-in ladder with no obstructions.
- One standard interchangeable section which can be used as a top, middle or bottom section.
- Universal base mount.
- Dual purpose mast or rotator mounting brackets.

There's only ONE

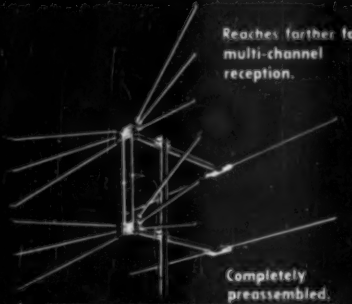
SUPER FAN

313 Series

The most widely used antenna in the nation.

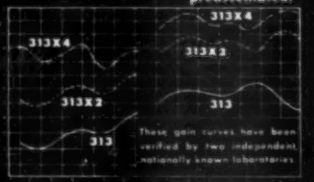
The highest gain broad-band antenna ever developed.

New reinforced fibreglas inserts in all elements and reflectors.



Reaches farther for multi-channel reception.

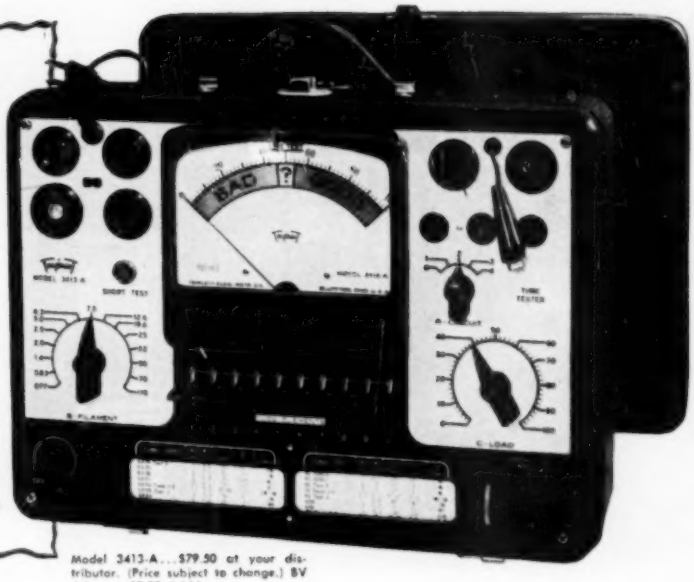
Completely preassembled.



Write for technical literature on these 3 outstanding products.

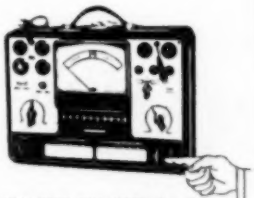
CHANNEL MASTER CORP. ELLENVILLE N. Y.

For accurate flexible and quick tube testing at low cost... model 3413-A



Model 3413-A...$79.50 at your distributor. (Price subject to change.) BV Adapter, $7.90 Add'l.

1. **YOU CAN TEST MORE TYPES** of tubes, also appliances for shorts and open circuits.



2. **JUST SPIN THE KNOB**—for correct, last-minute data, on the speed roll chart. Lists 700 tubes.

3. **YOU CAN COMPENSATE** for line voltage—just throw snap-action switch.

4. **YOU CAN TEST EACH ELEMENT** in each tube—by a simple flip of the switch.

5. **YOU CAN TEST THE NEW TUBES**—including those with low cathode current.

6. **YOU GET NEW TUBE DATA**—immediately, while it is still news. No waiting.

Nearly Half a Century of Service to the Service Man

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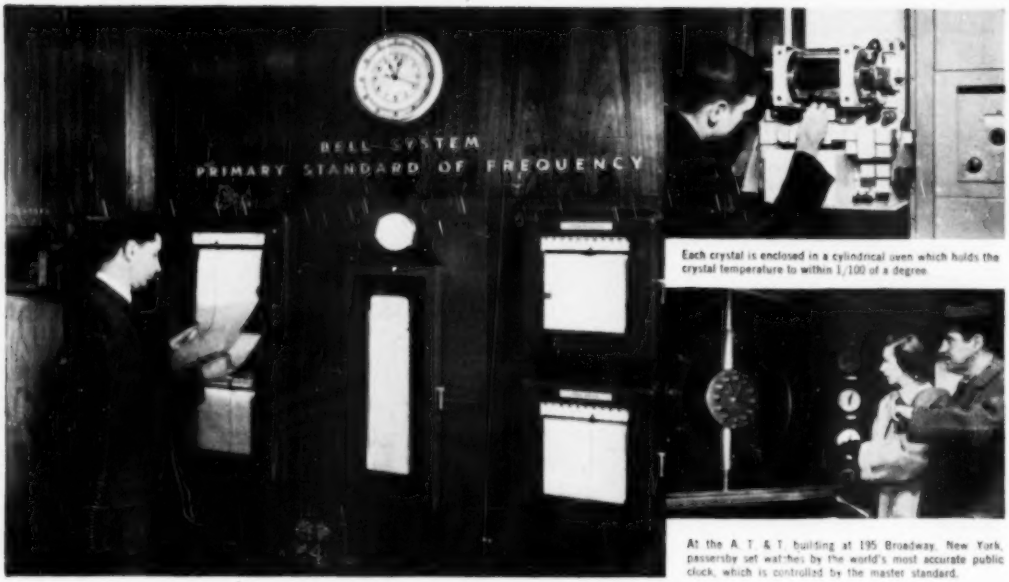

Each crystal is enclosed in a cylindrical oven which holds the crystal temperature to within 1/100 of a degree.

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A Front of the new frequency-time standard at Bell Telephone Laboratories. In the rear there are 600 electron tubes and 25,000 soldered connections. Room temperature is maintained within two degrees.

The controlling quartz crystal vibrates in vacuum at 100,000 cycles per second. The standard is powered by storage batteries, with steam turbo-generator standing by, just in case of emergency.

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Ever since Galileo watched a lamp swinging in the Cathedral of Pisa three centuries ago, steady vibration has provided the practical measure of time. In the 1920s Bell Laboratories physicists proved that the quartz crystal oscillators they had developed to control electrical vibration frequency in your telephone system could pace out time more accurately than ever before.

The Laboratories' latest master standard keeps an electric current vibrating at a frequency that varies only one part in a billion, keeping time to one ten-thousandth second a day.

Through secondary standards, a master oscillator governs the carrier frequencies of the Bell System's ship-to-shore, overseas and mobile radio-telephone services, the coaxial and *Radio Relay* systems which transmit hundreds of simultaneous conversations, or television. In the northeastern states, it keeps electric clocks on time through check signals supplied to electric light and power companies.

The new standard also provides an independent reference for time measurements made by the U. S. Naval Observatory and the National Bureau of Standards. Thus, world science benefits from a Laboratories development originally aimed at producing more and better telephone service.

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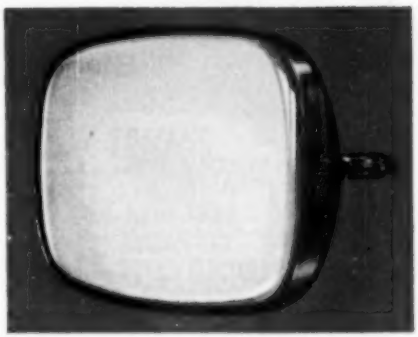
"That's swell, Sam! I've sure been losing sales I shouldn't. I need that CBS-Hytron Easy Budget Plan. CBS-Hytron tubes are tops, too. Thanks for the tip. I'll see my CBS-Hytron distributor today."



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Spot Radio News

** Presenting latest information on the Radio Industry.*

By RADIO & TELEVISION NEWS' WASHINGTON EDITOR

NATIONAL DEFENSE AND ELECTRONICS, which once again are closely allied in a global program of strategy, production and operation, have begun to dominate all spheres of activity in Washington with the same impact of the '40 to '45 era. The so-called temporary buildings, erected for interim tennacy during the war days, are once more bulging with the staffs of countless defense agencies. Every official building and numerous private and business quarters leased for government business have become the roaring headquarters of hundreds of departments established for the defense effort. Once more, meetings and conferences are highlighted by talks of members of officialdom, with the military playing their usual key role and revealing sharply our present problems and possible solutions.

During one such report covering the state of the Armed-Forces' requirements, Rear Admiral John R. Redman, who was recently named Director of Communications and Electronics on the Joint Chiefs of Staff, told members of the RTMA Transmitter Division that more than ever before industry and the military are partners in an enterprise to provide operational aids that will insure superiority over any potential enemy, on the land, on the sea or in the air. "Some of the military (supply) problems have their roots in the different organizational structure of the three military departments," he added, "as well as the different areas of responsibility of organizational divisions, common civilian-military functions, relationship with our allies in the North Atlantic Treaty Organization, relationship with other friendly nations, impact of the present Korean action and last but not least, the constantly changing world situation."

Noting that one of the major advantages we enjoy today over any potential enemy is our productive capacity, the naval specialist pointed out that this feature can be traced clearly to the standardization gains that have been made in all fields of endeavor.

Describing for the first time just how equipment for the military is transferred from an idea to the battlefields, the Admiral said that the gear usually grows from a statement of a requirement by an operational component of the military. Classified as a statement of military characteristics, it is passed on to the research and development activities of the military, with action on the requirement monitored by the research and development board. This Group is charged with coordination of all of the *Department of Defense* research and development activities. When the equipment has been developed and must be evaluated, operational personnel of the military appear on the scene again. The evaluation procedure was described as quite different from that practiced in the civilian world where the decision usually centers on one factor, profit or loss. In the military consideration, it was said, the freezing of the development must be evaluated in a less tangible economic fashion. In this instance, the factors to be considered are the number of battles that can be won and the bloodshed that could possibly be avoided.

The industry committee was told, after the equipment is evaluated and found satisfactory by operational personnel of the Armed Forces, procurement actions by the various departments are initiated so that industry can produce. At this point the Munitions Board enters the picture, since it is responsible for the allocation of industrial potential and materials to satisfy production requirements. It was pointed out that the board also serves as the focal point in equipment standardization problems.

Reviewing the personnel serving on the joint communications-electronics committee of the Joint Chiefs of Staff, who correlate the requirements of the Armed Forces, the naval chief said that all the branches of the services are represented: Major General G. I. Back, Chief Signal Officer of the Army; Major General R. C. Maud, Director of Communications of the Air Force, and Captain W. B. Goulett, Director of Naval Communications. Six assistants from the Army, Air Force and Navy complete the staff.

In a summarization of the job to be done, Admiral Redman declared that the military is doing its best to supply clear requirements so that industry can satisfy the wants of the military and take pride in a job well done. He pointed out that industry is developing the state of the art at a rapid pace, developing manufacturing techniques which produce reliable

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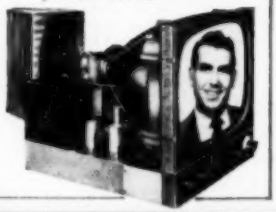

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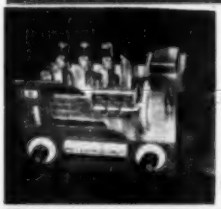

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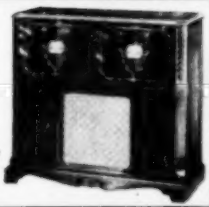

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IN ANOTHER DEFENSE INDUSTRY meeting, described as one of the most significant of the year, which had been called to review the edict to stop color-set production, the halls of Washington overflowed with the members of the manufacturing, alphabet agency and Armed-Forces world. Among those who appeared were Brig. General David Sarnoff and Frank M. Folsom, board chairman and prexy of *RCA*, respectively; *CBS* President Frank Stanton; Dr. Allen B. DuMont of *DuMont Labs;* Barney Balaban, *Paramount Pictures;* William Balderston, *Philco;* Benjamin Abrams, *Emerson Radio;* Paul V. Galvin, *Motorola;* Dr. W. R. G. Baker and Herbert M. Estes, *G.E.;* Richard A. Graver, *Admiral;* Richard Hodgson, *Chromatic Television Labs*, the *Paramount Picture* unit which announced recently that it would produce a tricolor tube; Arthur Matthews and C. J. Burnside, *Color Television, Inc.;* Lewis Clement, *Crosley;* Fred Gluck, *Fada;* W. A. McDonald, *Hazeltine;* John A. Rankin, *Magnavox;* W. L. Viergever, *John Meck Industries;* Joe Friedman, *Trav-Ler;* H. A. Gumz, *Webster-Chicago* (which had announced that it would produce converters and adapters for Columbia color); Robert S. Alexander, *Wells-Gardner;* F. M. Sloan, *Westinghouse;* R. J. Sherwood and Ernest Kohler, *Hallicrafters;* Louis A. Movins, *Paramount Film Distributing Corp.;* and attorneys Paul Porter (*Paramount*) and William A. Roberts (*DuMont*).

There were varied opinions on the propriety of the defense chieftain's order, but all said that they certainly would comply with the request to halt color chassis making as long as research could continue. Some legislators at the meetings appeared to be quite miffed at the ruling, declaring that the effort to avoid a growing black and white set market, the continuing "incompatible - compatible" argument placed before the FCC, was completely negated and any chance of popular acceptance of the disc system at a remote date was now an impossibility. Particularly caustic in his criticism of the *ODM* ruling was Senator Edwin Johnson, who had pressed for a color decision. He felt that the edict could have been withheld since the material required was trivial. Others believed that Wilson was entirely proper in his request, particularly in view of the need for nearly a quarter of a million fractional horsepower motors, which are not around in any substantial quantities now and which may become scarce as the copper situation becomes more and more critical.

As the color-set lines shut down, the labs continued their round-the-clock studies to evolve an electronic compatible system which might be mar-

(*Continued on page* 114)

RADIO-ELECTRONIC Engineering SECTION

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RADIO & TELEVISION NEWS

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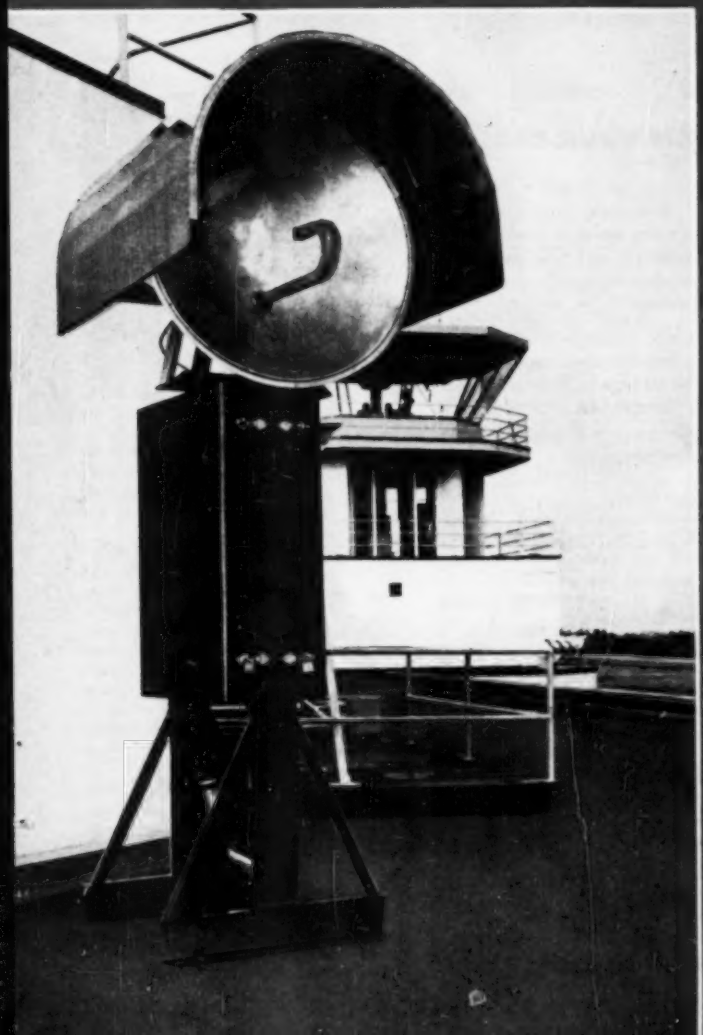

JANUARY, 1952

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The antenna of a Motorola microwave relay system. Systems of this nature were installed at airports by Aeronautical Radio, Inc. to transmit signals between airport control towers and air/ground radio control antenna arrays at points away from airfields.

COLOR TV STATUS

THE RECENT NPA order halting production of color TV receivers did not materially affect research and development work in this field. Successful large-screen theater demonstrations of color by *RCA* in this country, and demonstrations of the *Eidophor-CBS* system in Zurich, Switzerland, indicate that color TV for theaters, at least, is in an advanced state of development.

The National Television System Committee (NTSC) has accomplished a great deal with respect to recommending suitable standards for a compatible color television system. The chairman of this committee, Mr. W. R. G. Baker, outlined these proposed standards in a recent report.

According to this proposal, three different characteristics of the color picture are transmitted. These are the brightness, hue and saturation. The brightness information is transmitted in the usual fashion, as in a black-and-white picture. In addition, a "color carrier" is added, with a frequency which is an odd multiple of one-half of the line frequency. The sidebands containing the color or chromaticity information are thus interlaced with the brightness signal spectrum, utilizing more fully the available 4-mc. bandwidth. The two chromaticity signals, hue and saturation, modulate this color carrier in two different ways, for example, in amplitude and in phase, so that all of the color information is contained in the single color subcarrier. Thus, existing receivers could receive pictures in black-and-white from a color TV transmitter without any alterations by making use of the "brightness" signal, making the system completely compatible.

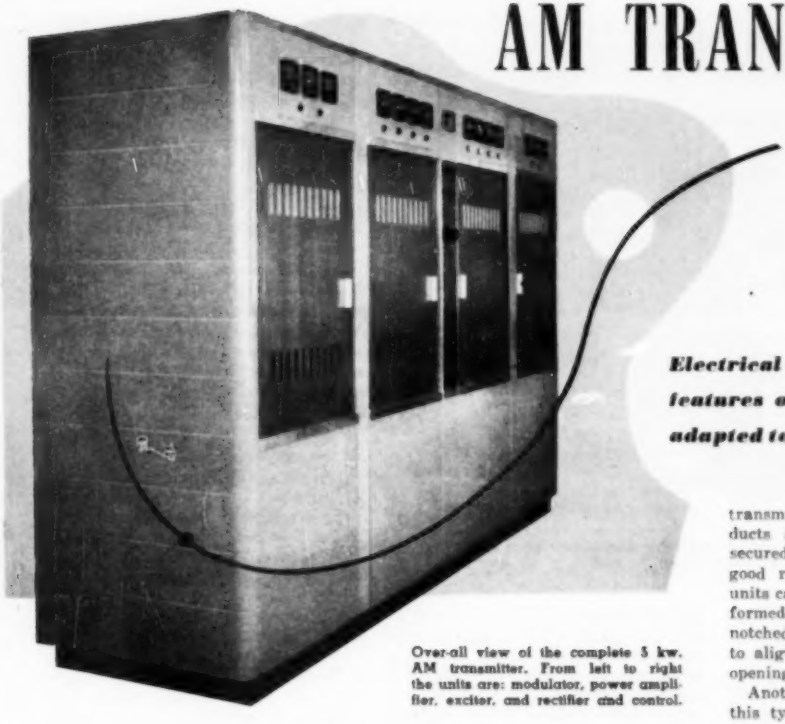
Most of the components of such a system have been tested extensively, and have been proved practicable. These tests are continuing, and further refinements are being worked out. One such refinement is the "oscillating color sequence" proposed and tested by *Hazeltine*. This technique greatly reduces adverse effects resulting from errors in the modulation of the color sub-carrier, and those due to interference of various kinds.

It appears very likely that a complete, compatible color television system, accepted by the industry, will be ready for presentation before the FCC within a reasonably short time. Work on this system cannot be considered to detract from our defense effort, since an acceptable color TV system would be very desirable to many branches of our military forces.

AM TRANSMITTER DESIGN

By M. H. HUTT
Engineering Products Dept., RCA

Electrical and mechanical design features of a unit which can be adapted to 5 or 10 kw. operation.



Over-all view of the complete 5 kw. AM transmitter. From left to right the units are: modulator, power amplifier, exciter, and rectifier and control.

FIRST CONSIDERATIONS in the design, planning, and mechanical layout of a new transmitter are the basic needs and operating requirements to be met in the broadcast field. Most of these technical requirements have been very well established by broadcasters with over thirty years of operating, or "on-air," experience.

Therefore, in the design of the *RCA* BTA-5G/10G (5/10 kw.) Transmitter, care was exercised to retain the many design features "proved-in" by its predecessors, as well as providing new and novel ideas. Listed here are some of the major factors which had to be taken into consideration in the final design.

1. Reduced cost, without any sacrifice in quality.
2. Reduced weight and size.
3. Simplified operation and maintenance.
4. Simple and easy installation.
5. Convenient and economical conversion to 10 kw. operation, plus addition of phasing equipment.
6. Accessibility to all components and tubes.

The 5 kw. transmitter consists of four major units; namely, the exciter, the power amplifier, the modulator, and the power rectifier units. With the addition of a few components, it can be converted into a 10 kw. unit without increasing cabinet and floor space. Cabinets of companion design and styling for phasing equipment may also be added where directional operation is required.

Each cubicle or cabinet measures approximately 27" x 30" x 84". Solid, rigidly formed panels of ⅛" thick aluminum are used to construct the cabinet enclosures. This fact alone accounts for a considerable saving in weight and increases the ease with which the units can be handled. Additional interior space is also gained by using the formed panel construction.

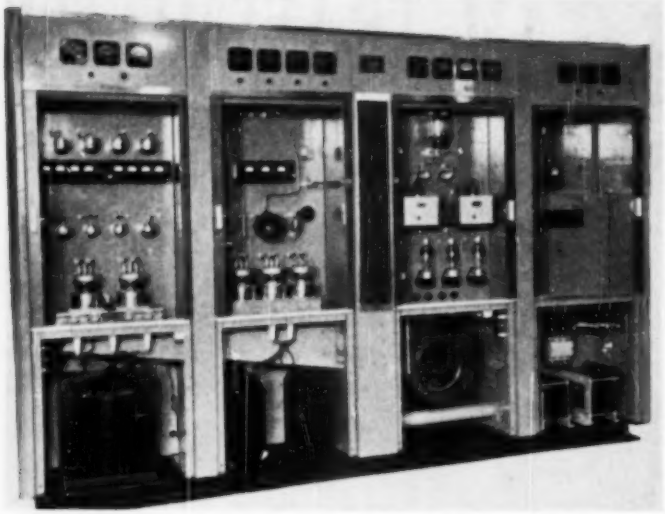
A sturdy steel base, used to support the vertical chassis and the two vertical side panels, has also been formed to allow the fork of a "pilot" jack (small hand or motor-powered lift truck) to reach under and through it for moving individual units during assembly and test. The four cabinets, completely assembled, require a total floor space of only 10 feet 10 inches in length, by 30 inches in depth. The sliding doors make it possible to conserve additional floor space because no clearance is needed to accommodate hinged doors.

Two wire ducts, one for the front and one for the rear, made of formed sheet steel, are long enough to reach the entire length of the four units comprising the complete transmitter. When the transmitter is installed, these wire ducts are first located, leveled, and secured to the floor. This provides two good rails on which the transmitter units can be set and finally located. The formed bases of each cabinet are notched to clear the wire ducts and also to align themselves up with the cable openings.

Another advantage of a wire duct of this type is the ease with which the interconnection cable and power connections can be installed. The wire duct is open along the entire front side, as are the "U" shaped notch openings for the cable connections of each unit. Thus, the interconnection cable may be simply laid in place, and the task of weaving the cable in and out of openings and holes is eliminated. As the cable is placed in the duct, each branching leg of wires automatically extends up through the notches provided in the base units to its appropriate terminal board.

On each base unit are assembled the vertical chassis and the two vertical side panels which are fastened together to form an "H" section. However, prior to assembling the cabinet unit, the vertical or center chassis may be assembled and wired as a sub-assembly item. In all units except the exciter, this vertical chassis divides the unit into two equal front and rear compartments. In order to provide additional space for a blower in the lower compartment, and to allow accessibility to the crystal oscillators and other components, the chassis in the exciter is forward of the center and does not extend into the lower compartment.

Two shelves, one front and one rear, located approximately 30 inches from the floor, further divide the units into upper and lower compartments. This



Front view with sliding doors opened and lower panels removed to show the interior arrangement. The mechanical layout is similar in all four units.

provides a means for mounting additional equipment which must be fixed in place. In the modulator and power amplifier units, the front shelves provide means for supporting the Type 5762 air-cooled power tubes. The air is piped from the blower mounted in the exciter through a duct system assembled directly to the under side of the shelves. The compartments below the shelves are used front and rear to house the heavier components which rarely require service. Removable panels below the door area provide easy access to these lower compartments. These lower panels are quickly removed by releasing two camlock fasteners just inside the lower edge of the door opening above the shelf. An interlock switch provides the protection against high voltage when these panels are removed. All large transformers, reactors, voltage regulators, capacitors, circuit breakers, etc., are housed in the lower compartments and the blower is situated in the lower compartment of the exciter. The lower rear panel of the exciter unit also contains an "intake" air filter. This filter is a dry type and can be cleaned with a vacuum cleaning attachment without removal from its mounting.

The upper front and rear sections of each unit contain the components which require occasional attention and service. This requirement is facilitated by the use of new, horizontal, sliding doors. Interlocking, extruded aluminum slats are used to make the doors. Small rubber caster assemblies, riding in an upper and lower track, guide the doors as they move from the front to the side of the cabinets. A four-inch separation between units provides the space into which the opened doors slide, with one door entering from the front and another from an adjacent cabinet entering from the rear. A series of openings in certain slats provide the windows necessary for observation of tubes and components. These openings are protected with plexi-glass held in place by small spring clips for easy removal. Each door is equipped with a latch assembly which locks the door in place while closed and is easily tripped while pushing the door open. The door also activates an interlock switch and a ground switch, which both operate at the desired position of the door to provide full protection. However, the front door of the rectifier and control unit is not interlocked and, therefore, provides access to main switches and circuit breakers.

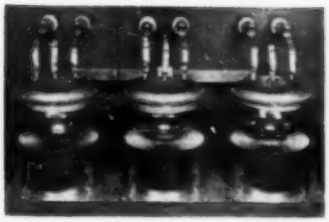
Above the sliding doors on the transmitter front are the meter panels for mounting meters and indicator lamps. Below the doors are the lower removable panels. Both panel areas are separated from the door area by trim strips. In general, over-all external appearance and styling matches other existing *RCA* transmitter equipment.

The four-inch spaces, provided between units for housing the open doors and door tracks, are covered with filler channels which are fitted into the over-all styling. The center filler channels are eight inches wide and the front center channel contains the external transmitter controls.

Both units adjacent to the center section have only their rear doors entering this area. This arrangement leaves the front section free for locating the necessary controls. There are only two units with components requiring external tuning controls: the power amplifier to the left of the control panel contains a variable vacuum capacitor, controlled manually by a vernier dial mounted on the door jamb adjacent to the control panel; and the exciter to the right of the control panel has a "slug-tuned" coil, controlled manually by a similar dial located on its door jamb. Therefore, these dials are in the vicinity of the control panel and may be grouped with the other controls to form a central control panel. No further mechanical mounting is required, since installation of these assemblies is part of the completed unit.

Internally, the mechanical layout and arrangement is similar for each of the four transmitter cabinets. As mentioned previously, each unit is made up of a vertical chassis and two vertical side panels fastened together to form an "H" section. The shelf level is just about even with the lower edge of the door. Except for the exciter unit, the vertical chassis extends from the base to the top cover. In addition to a more simplified assembly, all the smaller components assembled on these chassis are made extremely accessible. The small tube sockets are mounted vertically, and the tubes horizontally. This arrangement makes all wiring easily visible and accessible. The chassis is placed approximately fifteen inches from the door opening, so that all components on the chassis are within easy reach. All components such as capacitors, resistors, coils, etc., are, in most all cases, mounted on the rear side of the chassis. This results in a clean arrangement on the front of the chassis where only the necessary tubes, meters, crystal oscillators and associated components are mounted.

The modulator and power amplifier units are very similar in internal arrangement and follow the general "chassis and shelf" layout described above. The associated power-rectifier unit is divided similarly into compartments for housing the components which supply the voltage to the modulator and power amplifier. The front compartment behind the door of the power-rectifier is accessible at all times and is not interlocked, but fully protected to permit operation of control switches. The rear compartment of this unit, behind the door, contains a special thyratron control circuit, the components of which are arranged on a hinged insulated chassis. An insulated shelf is also used to support the thyra-



Mechanical assembly of the Type 5762 tubes used in the power amplifier unit.

tron tubes which are visible from windows located on front of the transmitter door. A set of arc-back indicator lamps is also mounted on the thyratron tube shelf and is visible through jewels mounted in the vertical chassis.

A single blower, located in the lower part of the exciter cabinet, supplies all the air required for cooling the power tubes in both the modulator and power amplifier. Additional cooling required for components is also piped and bled from this same source. The air is carried from this common source by a simple air duct system that is part of the individual cabinet assembly, as described previously. Smaller pipe ducts or openings leading off the main ducts direct the air to the required "hot-spots."

Directly above the air ducts on the shelves of the modulator and power amplifier are mounted the 5762 tubes on an insulated box type mounting. This box is made of mycalex stock of sufficient size to provide the support and insulation required. This assembly is divided in the modulator to provide two separate tube mountings for a push-pull connected arrangement. In the power amplifier, the assembly is combined to provide a parallel connected arrangement for two tubes when operating at 5 kw., or three tubes when operating at 10 kw.

The four thyratron tubes, located in the rear of the "power-rectifier" because of their function, are spot cooled by a small blower assembly mounted below the tube shelf. Except for this small unit blower, all cooling air is supplied by the one main blower driven by one motor. There is one air filter to service; maintenance, in general, is minimized.

The blower motor is coupled to the wheel through a variable pitch pulley and "V" belt. The drive thus provides for variations in air requirements due to differences in altitude locations or whether operating at 5 or 10 kw.

The cooling air is vented through perforated covers in the tops of the cabinets. If it is exhausted into the operating room, ventilating fans located near the ceiling may be used to discharge the heated air in the summer or, in the winter the exhaust air from the transmitter may be used to heat the room. If the operating room is air conditioned, the heated air from the transmitter may be exhausted outside by ducts leading from the tops of the cabinets.

The addition of two reactors, a power amplifier tube with its voltage regulated transformer, and a few minor components is all that is required to convert from a 5 kw. transmitter to a 10 kw. transmitter. The space and mounting facilities for this conversion are provided in the 5 kw. design without additional space or expense and kept within the limitations of the original size and design.

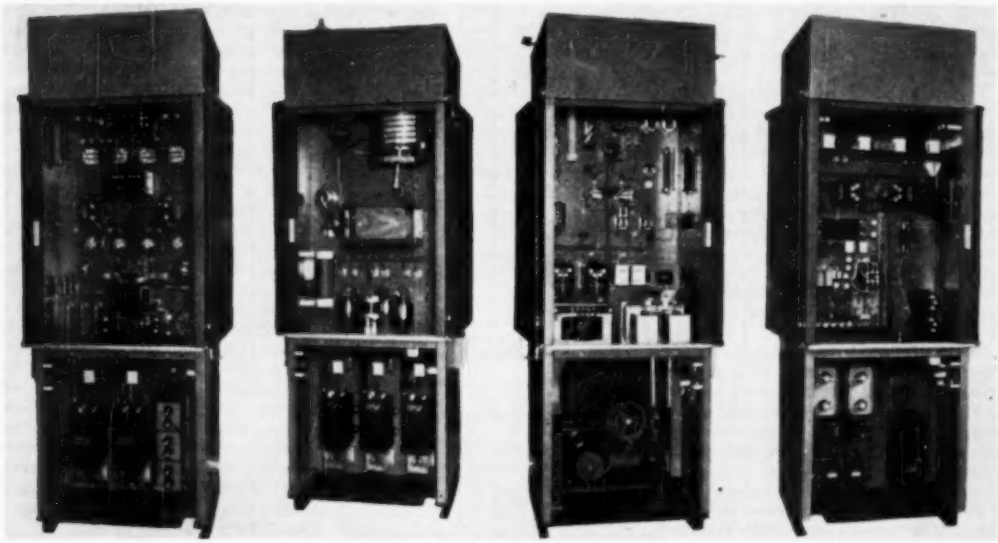
Provision has been made in the design for easy addition of cabinets for phasing or audio equipment. These cabinets are similar in design and are supplied as required by the individual radio station. By using a combination of wire ducts, filler channels and trim strips, these additional cabinets are easy to install and blend well with the over-all styling. The new BTA-1M Transmitter (a 1 kw. AM transmitter) has also been designed to be housed in a single unit of this same design. Therefore, it can be installed adjacent to the BTA-5G or 10G as a "stand-by" unit and still be in harmony with the over-all equipment.

Installation has been further simplified by the fact that each unit is shipped completely assembled, except for the few components that are removed to prevent damage in transit. Except for the interconnection cable, one buss, three "boot," and three ground strap connections are all that are required during installation. Wire duct covers, end shields, filler channels and top trim strips are all assembled with a minimum of hardware, using the same size throughout.

The control panel on the front center filler channel is easily removed for servicing by removal of several screws and four cable plugs. Thus, the control

(*Continued on page 29*)

Rear view of the various units with interiors exposed. Left to right: modulator, power amplifier, exciter, and rectifier and control.



Comparison of several models of the Balitron with a conventional 6V6GT. Shown from left to right are a type 6V6GT, and the Balitron voltage amplifier, negative resistance amplifier, and power amplifier.

CIRCUITS of the BALITRON TUBE

By
NORMAN Z. BALLANTYNE

The stable negative resistance characteristic of the Balitron can be utilized in several useful circuits.

THE DISCUSSION of the new Balitron Tube, which appeared in the March and April, 1951, issues of this magazine, mentioned several new circuits which are applicable only to this type of tube. These strange circuits include a converter which has the stability of a crystal-controlled oscillator without heat compensation, but is a true v.f.o., a new type of electron coupled oscillator, a negative resistance amplifier which uses positive feedback to prevent oscillation, a zero plate resistance amplifier, and a direct-coupled amplifier circuit using a common power supply.

Perhaps the characteristic that contributes most to these unique circuits is the negative resistance characteristic which has been obtained with several test models of the Balitron. Negative resistance, where a decrease in applied voltage causes an increase in plate current, has been used before in the dynatron and transitron oscillator circuits, as well as others.

In the Balitron Tube, no critical biasing circuits are required to produce the negative resistance characteristic and it does not depend upon secondary emission. As a matter of fact, the negative resistance characteristic of the Balitron is developed by only slight changes in the tube element position from the normal positive resistance operation position. Negative resistance becomes, therefore, a characteristic of manufacture and a stable element at ordinary operating voltages.

Before we see how negative resistance is developed, it would be well to review the normal operation of the tube. In Fig. 2A we have a plan view of one model of the Balitron. In the normal operation of this tube, electrons are emitted from the cathode K and are formed into a beam whose major axis is at right angles to the plane of the paper. This beam-forming action is accomplished by the structure G_1, which is a solid metallic shield partially surrounding the cathode. Electrons in the beam are accelerated off the cathode wall by the field of attractive potential set up between the accelerating anode A on one side of the beam, and the positive deflection plate P_4 on the other side. This attractive field accelerates electrons through the beam opening in G_1 and projects them through the plane of acceleration into the deflection area of the tube. The fields existing between P_4 and the negative deflection plate N_4 act upon the beam to bring it to a point of focus near the edge of the separator plate S_1. The beam is then split by the mutual electron repulsion, caused by the rapid increase in electron density per unit of space, and the repulsive field of the separator plate which is operated at ground potential. As a result of these forces, the beam is split so that under no signal conditions equal amounts of current flow to the target anode T_2 and the target plate T_1.

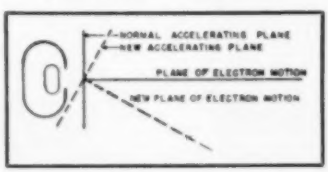
Control is accomplished by changing the focal length of the beam so that it is deflected either into T_2 or T_1. The beam is extremely sensitive to voltage changes upon N_4 because, unlike ordinary deflection tubes, only a small part of the beam needs to be deflected to change the focal length.

With the essentials of the normal operation of this tube in mind, we can refer to Fig. 2B and see how negative resistance is developed in the Balitron. Basically, this is the same tube as shown in Fig. 2A. The major difference is the change in the G_1 structure near P_4, where a slight extension is made on G_1 in the direction of electron acceleration. This is coupled to the slight change in the P_4 position to produce change in the plane of acceleration. In the normal tube, where the plane of acceleration is at right angles to the normal plane of electron motion, determined by erecting a line at right angles to the cathode wall and bisecting the G_1 opening, the new location of P_4 and the extension of the G_1 structure shifts the plane of acceleration. This action causes the electrons to be accelerated in a direction which lies below the reference plane, as seen in Fig. 1.

Since the electrons are projected at a greater angle with respect to the surface of P_4 than in the ordinary case, the voltage applied to P_4 has much greater difficulty in deflecting the electron beam. As the voltage applied to P_4 increases, the projection angle of the beam will be increased away from P_4, and the electron velocity will be increased.

Both of these characteristics make it more difficult for P_4 to attract electrons and produce a reduction in the current drawn as the voltage is increased. Thus,

Fig. 1. Comparison of normal plane of electron motion with new plane resulting from extension of electrode G_1.



negative resistance for the P_d electrode is established.

As the T_p voltage is increased, it effectively builds up the field near P_d, since this is a relatively unipotential area. Thus, a negative resistance characteristic is established for T_p as well as P_d.

Of course, as either the P_d or T_p voltage decreases, the amount of angular shift produced in the electron beam is reduced and a greater number of electrons are received upon T_p and P_d, since they can be attracted more readily with a reduction in the energy level of the electrons. A reduction in voltage on either P_d or T_p below a critical level will reverse the resistance characteristic from negative to positive for the member concerned.

Relatively stable conditions of negative resistance operation have been obtained. Typical values are a slope yielding 13,000 ohms of negative resistance for P_d, and up to 40,000 ohms for the combined elements. These values were obtained with two hundred volts applied, and extend over an appreciable voltage range.

The negative resistance slopes obtained for the ordinary pentode and tetrode extend over relatively small values of voltage and current. As a result, the usable values of negative resistance are limited. In the negative resistance Balitron, however, the slope extends over much larger values of voltage and current, and the consequent usability of the negative resistance characteristic is extended. This can be seen from reference to Fig. 3 which shows a graph of the negative resistance slopes of P_d, T_p, and the combined curve of both.

In view of the much better negative resistance characteristic, it would be applicable to review the various circuits which use it. One of these circuits is the negative resistance oscillator. Despite the extreme stability of this oscillator, established as closely approaching the stability of the Pierce crystal, it is seldom, if ever, used outside the laboratory. One obvious reason is the extremely low efficiency and the resultant low power produced with the pentode tube. With an increase in power output, it would seem to be of extreme value.

The Balitron is adaptable to the operation of a negative resistance oscillator by simply inserting a tuned circuit having an impedance equal to, or greater than, the value of negative resistance in the circuit of P_d, T_p, or the combined elements, depending on which negative resistance slope is used. A typical circuit is shown in Fig. 6A where the combined elements are used. A more complex, but even more stable and powerful, circuit is the negative resistance electron-coupled oscillator which is shown in Fig. 6B.

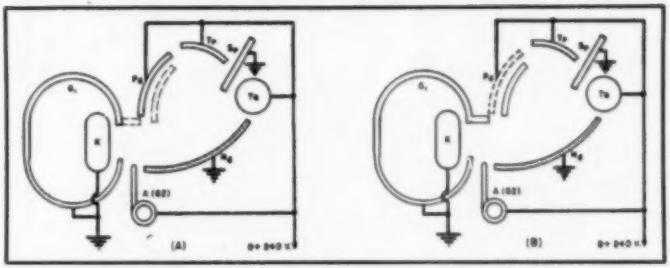


Fig. 2. (A) Plan view of one model of the Balitron. (B) Plan view of negative resistance version. Dotted lines in each case show the other version.

In this circuit, the negative resistance of T_p and P_d causes oscillation to occur across the tank circuit composed of C_t, L_t. Since relatively high values of resistance are obtainable, the tank impedance can be relatively large without driving off the negative resistance curve as high impedance tanks will do where they greatly exceed the internal resistance of the tube.

As oscillation is developed within the tank by negative resistance action, sinusodial variations in the current flowing to T_p will result. This change in current appears upon T_p and is applied to the tank circuit L_t, C_t, which is tuned either to the same frequency as L_t, C_t, or to some multiple of that frequency. Thus, the negative resistance tank provides the frequency control of the circuit, with this frequency control electron coupled to the output tank through current variations. It is obvious that loading of the negative resistance tank is eliminated, and the output tank impedance is not necessarily held to the values required for negative resistance operation. The stability should thus be greatly improved.

Another possibility for increasing the effectiveness of this oscillator is the circuit shown in Fig. 6C. This is a negative resistance oscillator employing feedback

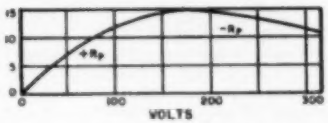


Fig. 3. Graph showing negative resistance slope of Pd and Tp.

to increase the effective power of the oscillator without decreasing the stability to any great extent. In this circuit, the negative resistance tank coil is center tapped. The coupling capacitor C_3 is inserted to couple the voltage present upon the lower end of the coil L_t to N_d. Phase relationships must be such that the N_d voltage changes in phase with the T_p-P_d voltage. A study of the circuit will show that this condition is satisfied. In the ordinary circuit, this in-phase feedback would be degenerative but here, due to the strange characteristics of the tube, it operates as positive feedback since N_d and T_p-P_d are in phase in any case. It is well to note that the negative resistance tank circuit is in complete control of the operation of this circuit. The feedback does not produce oscillation (that occurs in the tank circuit itself) but increases the power output that it is possible to obtain. Exactly what effects will appear in regard to stability have

Fig. 4. (A) The Balitron as a converter. (B) Amplifier circuit using the Balitron.

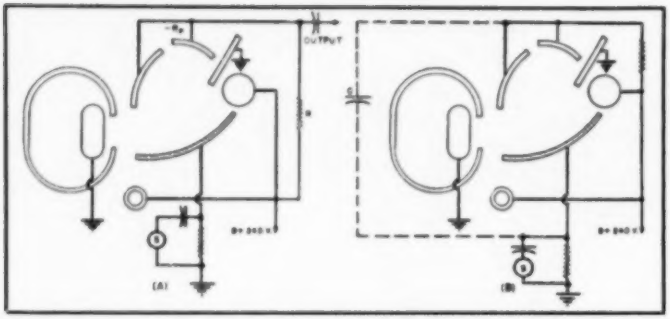


Fig. 5. (A) Negative resistance amplifier circuit. (B) Same as (A) with regenerative feedback provided by condenser C for the purpose of increasing gain.

not been established, but it is evident that stability will decline somewhat as the power output increases, due to the change in effective slope.

In these possible circuits, the startling frequency stability of the negative resistance oscillator is combined with an output tank to produce an oscillator having reasonable efficiency and power output. While no extensive tests have been made, it would seem that this oscillator would oscillate well into the v.h.f. region and provide a much wider basis for using this highly stable v.f.o.

While the negative resistance Balitron oscillator is still fresh, the possibility of using this tube as a converter must be considered. This circuit, shown in Fig. 4A, uses a tank circuit composed of C_1, L_1 tied to the negative resistance T_s-P_s. The variation in beam current thus produced is beating against the change in current produced by the signal voltage injected upon N_s by the signal tank circuit composed of L_2, C_2. The action of the signal voltage and the oscillator voltage will add when in phase, oppose when out of phase, and produce a resultant voltage when any phase difference exists. It is obvious that the output appearing upon T_s will be a heterodyne of the two frequencies. Converter action is thus accomplished with the highly stable negative resistance oscillator as a base.

Several advantages are inherent in this type of converter. The immense stability of the negative resistance oscillator is introduced with a no-drift tube to provide the extreme in tunable converter stability. The flow-back, or reverse current flow which takes place in an ordinary converter tube, is eliminated here since the modulating signals are applied simultaneously from opposite sides of the beam, not on consecutive control planes as in the ordinary case.

A third circuit using the negative resistance characteristics of the Balitron is the zero plate resistance amplifier. In this circuit, shown in Fig. 4B, the normal internal resistance of the tube is effectively cancelled out so that the total power is applied to the load. The concepts of this circuit involve not only the negative resistance T_p-P_s, but a positive resistance on T_s equal in magnitude to the negative resistance of T_p-P_s. In addition, the coefficient of coupling between L_1 and L_2 of the output transformer must approach unity.

In practice, the conditions of equal values of negative and positive resistance have been met with a negative resistance of 32,000 ohms on T_p-P_s, and the same value positive on T_s. Unity coupling was not, however, obtained.

In operation, the source (S) drives N_s throughout its cycle. On the positive swing, the I_{T_s} is decreased and the $I_{T_P\text{-}P_s}$ is increased, with a resultant decrease in voltage on this member. The decrease in T_s-P_s voltage, because of the negative R_p, tends to increase the $I_{T_P\text{-}P_s}$ but, at the same time, the increase in E_{T_s} tends to oppose this increase. The beam is then attracted equally by both plates and is free of the inherent resistance of either one. Since the internal R_p of the Balitron is the resistance of the beam to attraction by the plates and would normally damp the signal, it is clear that removing the damping action, by providing an equal attraction all over the voltage swing, is the same as removing the internal resistance.

The same action occurs on the negative swing, with the reduction in E_{T_s} caused by an increase in I_{T_s} being effectively cancelled by an increase in $E_{T_P\text{-}P_s}$ and, because of the negative R_p, a reduction in $I_{T_P\text{-}P_s}$. It is then clear that the internal resistance is cancelled out on both sides.

In this manner, while the factors of internal resistance are all present within the tube, the effective resistances to beam movement are cancelled out by self-controlled feedback. The whole resistance presented to the flow of current within the tube is cancelled out and all the power is applied to the load.

Quantitative analysis of the power gain has not been accomplished, but the circuit has been tested for voltage gain. Where the maximum gain factor

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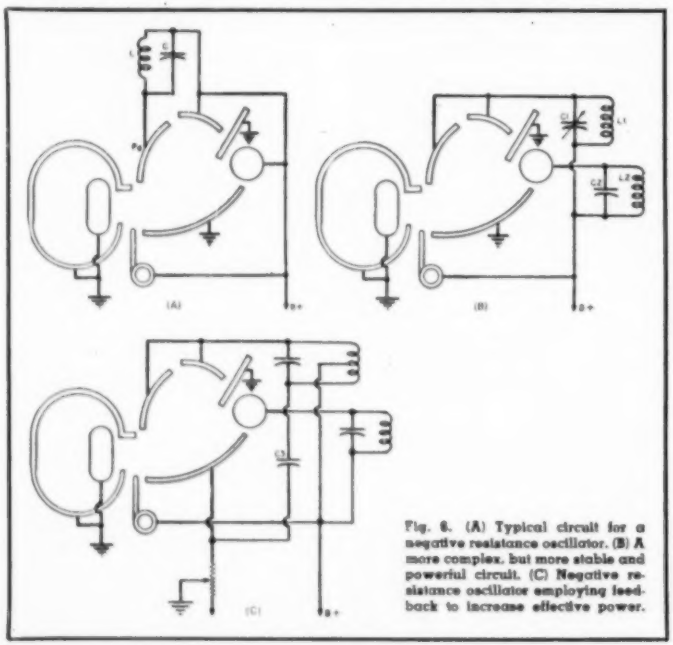

Fig. 6. (A) Typical circuit for a negative resistance oscillator. (B) A more complex, but more stable and powerful circuit. (C) Negative resistance oscillator employing feedback to increase effective power.

The Rectilinear AMPLIFIER

By
FRED JEWELL

Consulting Engineer
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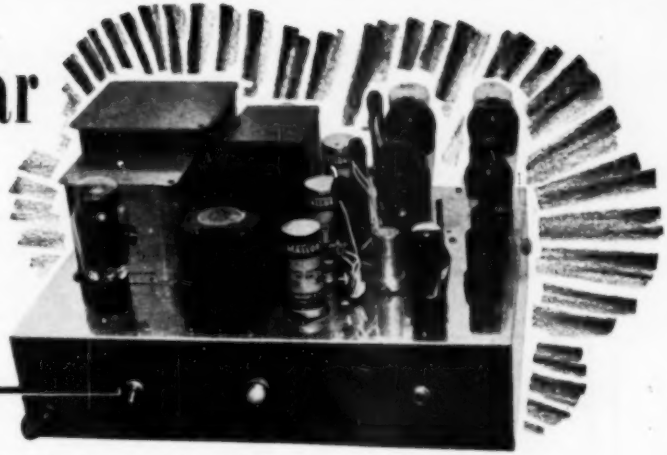


A completed version of the amplifier. It is used to amplify the output of a photocell in photoelectric engraving equipment.

A novel circuit is used to provide essentially flat response from zero to several kilocycles.

FOR SOME time there has existed a need for a device that could accurately amplify minute electrical signals resulting from electrical, mechanical, temperature and optical variations, over a range of frequencies from d.c. to several kilocycles. Existing circuits performing applications of this nature have had their shortcomings—principally instability, feedback, cumulative high voltage, grid blocking, high grid bias, etc. The necessary essentials of an amplifier to meet these exacting requirements are:

1. Straight line amplification from zero to several kilocycles in frequency.
2. Freedom from distortion and harmonics.
3. Absolute stability and high gain.
4. A time rise factor reduced to an absolute minimum.

Numerous tests have proven that the Rectilinear Amplifier presented in this article meets the above standards.

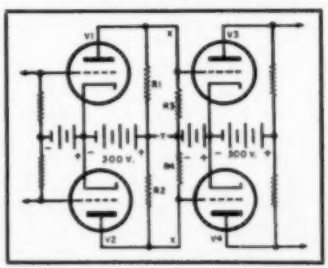
From a casual glance at the schematic diagram of Fig. 5, it may appear that this amplifier is nothing more or less than a push-pull, direct-coupled amplifier with a separate power supply for each stage. On closer inspection, however, it will be found that it is neither push-pull nor direct-coupled, unless a broad interpretation of a bridge-type amplifier could be called a push-pull amplifier. Although it is true that a bridge-type amplifier does automatically incorporate the push-pull principle, a push-pull type amplifier does not have the gain or stability of the bridge-type amplifier.

Granting the rectilinear amplifier does connect the plates of one stage of amplification to the grids of the following stage, it is not directly coupled; it is *directly connected*. By the use of a separate power supply for each stage, it is essentially an a.c. coupled amplifier. This new and unusual feature overcomes the inherent faults of a d.c. coupled amplifier and introduces advantages which will be outlined later.

Fig. 1 indicates the type of basic bridge circuit used, in which the output of one stage is directly connected to the input of the following stage. When all resistors are equal, the flow of current in R_1 and R_4 will be the same, and the potential across these resistors at points XX will be zero. Consequently, no potential will be impressed upon the grids of V_2 and V_4 other than the usual grid bias.

Consider V_1 and V_3 as electronic valves (shown in Fig. 2A), and KP_1 and KP_2 as the cathode-plate resistance of these tubes. If circuit KP_1 is closed and KP_2 is opened by a potential impressed upon the grids of these tubes, the bridge becomes unbalanced and the current will flow in the direction of the arrows. A potential difference of 200 volts will then be impressed between the grids of V_2 and V_4, the grid of V_2 becoming negative and the grid of V_4 positive. However, if a reverse potential is applied to the grids of V_1 and V_3, as indicated in Fig. 2B, it will also unbalance the bridge circuit and cause current to flow in the opposite direction. This will cause a potential difference of 200 volts to be impressed between the grids of V_2 and V_4, but the grid of V_2 will become positive and grid of V_4 will become negative. Therefore, the polarity is reversed across V_2 and V_4 by a change of polarity across the grids of V_1 and V_3. Tubes V_1 and V_3 cannot become completely closed or opened, but any variation of the cathode-plate resistance of these tubes, caused by a change of potential upon the grids, will cause a corresponding potential change across the resistors of the plate circuit of these tubes, within the limits of their characteristics. Actually this condition causes the circuit to become an electronic relay.

Fig. 1. The basic bridge circuit as it is used in the rectilinear amplifier.



It will be noted that if a physical connection is made at point Y, Fig. 1, the value of the bridge type of amplification is destroyed and it becomes a direct coupled amplifier. Also, a potential difference of 150 volts will exist between these two points, which would throw a high negative bias on the grids of V_2 and V_4. This would cause grid blocking and a consequent loss of stability and gain which would necessitate compensating measures to offset this problem, and thus tend to introduce other undesirable complications.

The primary objective of any amplifier is to convert a minute electrical signal pattern into an exact duplicate output power pattern which can be converted into mechanical and other forms of energy by a transducer. Consider Fig. 3, which could be a pattern of an input voltage variation, regardless of whether

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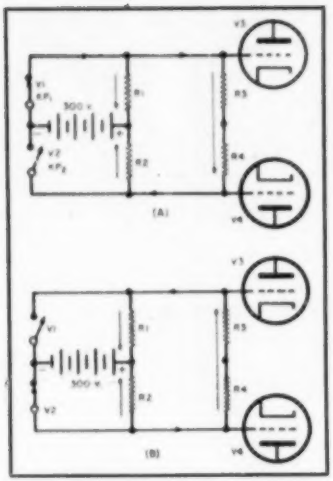


Fig. 2. Analogy of the theory of the circuit (A) with one polarity, and (B) with the polarity reversed.

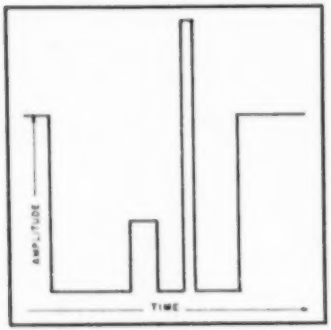


Fig. 3. Representative signal pattern.

or not this would be radio signal impulses, signals from a generator, variation of light density impinging upon a photoelectric cell, or a low frequency audio signal such as that appearing at a phonograph pickup from either wire, tape, or a mechanical recording.

An amplifier which would give an output which is an exact duplicate of this pattern, without any slopes or rounding of corners, could be considered an amplifier with suitable characteristics. It is limited only to the time required for the current to built up in the circuit. For most practical purposes, the time rise factor is very low when pentodes are used.

An amplifier which uses any method of impedance coupling from one stage to another in cascade amplification, such as condensers or transformers, could not reproduce this pattern as effectively, due to the finite time required for current to build up in inductance and capacity.

The first stage of the bridge-type amplifier (Fig. 1) provides the basic circuit requirements. It can measure illuminations corresponding to a phototube current of only 10^{-16} ampere. Although this circuit has little or no value as an a.c. amplifier, it will not float or drift and is very stable. In coupling this to another stage of amplification without a condenser or a transformer as a medium of coupling, we have an a.c. amplifier as well as a d.c. amplifier with the required characteristics.

This same circuit automatically incorporates the principle of push-pull amplification. The second and other even harmonic currents generated within the stage produce no effect on the output resistors and, hence, do not appear in the output circuit. Push-pull operation requires less filtering of the 60-cycle power and delivers more than twice the power of a single tube.

Interstage Coupling

The interstage coupling of cascade amplification in direct-coupled amplifiers presents the main problem. The fact that all the stages of the entire amplifier are in series, complicates this method considerably. This problem is best explained by considering Fig. 4, which shows two stages of intermediate coupling feeding an output power stage.

Assume the following:

1. V_1 is a low plate voltage tube of the order of 90 volts plate supply and 5 ma. current flowing in the plate-cathode circuit.
2. V_2 is a type of tube with characteristics of the order of 300 volts plate supply and current carrying capacity of 30 ma.
3. V_3 has a plate voltage of 450 volts and a current carrying capacity of approximately 100 ma.

This would mean that a total plate potential of 90 + 300 + 450 volts, or a total of 840 volts, would have to be applied to the amplifier. Therefore, there would be a potential difference of 840 volts between the input and output, involving all the difficulties of insulating and shielding, and the physical danger of this high voltage.

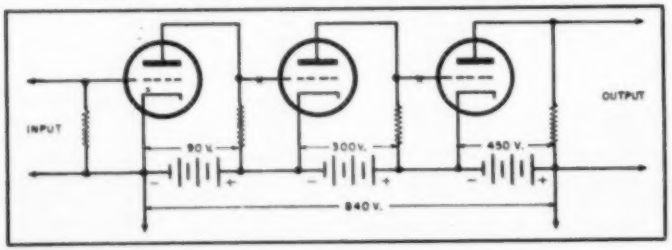
Now, as the plate of each preceding stage is directly coupled to the grid of the following stage, a high negative bias is applied to the grid of the next tube. This produces high negative bias at points X of Fig. 4. It may be overcome to a degree by means such as pointed out by Loftin-White in their direct-coupled amplifier but, here again, we introduce another complication to overcome the inherent objection of this type of an amplifier.

As pointed out previously, any change in the potential of the entire circuit affects the circuit as a whole. This especially applies to the grid-cathode circuit, as any change in potential of the grid-cathode circuit is amplified by the amplification factor of the tube itself, which will have a tendency to throw the amplifier into a state of oscillation. Once more, means may be introduced to overcome this difficulty to a certain extent, such as tube voltage regulators and line voltage regulators of the power supplied by an a.c. rectifier.

By considering the schematic diagram of Fig. 5, it becomes readily apparent how these objections are overcome and, in effect, this amplifier imbues all the characteristics of an a.c. amplifier. Yet it is directly connected and auotmatically takes advantage of all the fentures of a direct-coupled amplifier.

It is very important to understand that the B power supply for each stage is independent of the other supplies. This method of coupling eliminates the necessity of having to use a high positive grid bias on the grid of the following tube. Considered in another way, this circuit embodies the principles of resistance coupling without the use of condensers. It also incorporates the principles of the bridge-type amplifier with its advantages of high gain and stability.

Fig. 4. Circuit diagram of a conventional direct coupled amplifier with two stages of intermediate coupling feeding an output power stage.



Application and Characteristics

The schematic diagram of the complete, all-purpose amplifier, embodying all the principles covered in this article, is shown in Fig. 5. Under actual test, this amplifier will take the output of a

(*Continued on page 31*)

SLOT RADIATORS AND ARRAYS

The characteristics of slot arrays and the effects of slot position are detailed.

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ASSOCIATED WITH the electromagnetic field in a wave guide or other transmission line is the distribution of current over the boundary surfaces. The arrangement of current is such that a narrow slot may be cut into the transmission line parallel to the direction of current flow. This slot will not perturb the current distribution in the transmission line and will therefore not couple the internal field to space. Examples of this type of slot are the slots cut along the center lines of the broad sides of rectangular wave guides, those on coaxial lines which are parallel to the axis of the transmission line and those which are cut into the narrow side of rectangular wave guides normal to the guide axis. The first two examples cited offer a means of entry into the transmission system and are used to study the internal field configuration, usually connected with impedance measurements. The third example of a non-radiating slot has been used as a parasitic element in a Yagi array of slots.

If a narrow slot is oriented so that it is not parallel to the current lines, it will constitute a radiating element. The degree of coupling of the internal field to space depends on the current density intercepted by the slot and the component of the length of the slot transverse to the current lines. The type of circuit element that the radiating slot presents to the transmission-line representation of the wave guide is a function of the position and orientation of the slot on the wave guide.

Author's Note: The measurements recorded in this article are based on a slot width of 0.0625 inch in a 1.0 x 0.5 inch rectangular guide.

Linear arrays of slots may have carefully controlled illumination over the aperture. Such arrays may be used as antennas where the optical approach is unsatisfactory due to limitations of space, weight or windage requirements. The design of such arrays requires a knowledge of both the power radiated by each slot and the relative phase of the fields from each slot. Available data were used to design shaped beams and low side lobe level arrays. The results were not up to expectations so that improved data were desired. In addition, the phase of the fields radiated by slots other than the resonant ones was not known.

A series of measurements was performed on slots having their longitudinal axis parallel to, but displaced from, the axis of the wave guide. This type of slot may be represented as a pure shunt element across the transmission-line representation of the wave guide. The measurements were conducted at X-band, but the results indicate that the necessary information for designing arrays at other frequencies may be obtained with very few checking measurements. Direct scaling of parameters obviously may be used.

The admittance measurements were conducted along two lines:

(a) Direct admittance measurements using a traveling probe in a slotted wave guide and

(b) Calculations of the admittance of slots from radiation pattern measurements.

Slots having a conductance greater than 0.1 can be measured very accurately by the direct measurement technique. Lower conductance slots are measured more accurately by comparing them to a known high conductance slot in method (b) above.

The power pattern of 2 isotropic elements is proportional to:

$$P = A_1^2 + A_2^2 + 2 A_1 A_2 \cos (kd \cos \theta + \Phi) \quad . \quad . \quad . \quad (1)$$

where A_1 and A_2 are magnitudes of the excitation coefficients, $d + s$ the spacing, and Φ is the phase difference between the coefficients. The radiation pattern is maximum or minimum depending on whether $\cos(kd \cos \theta + \Phi)$ is $+1$ or -1. Then the ratio:

$$\frac{A_2}{A_1} = \frac{\left(\frac{P_{max}}{P_{min}}\right)^{1/2} - 1}{\left(\frac{P_{max}}{P_{min}}\right)^{1/2} + 1} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

is obtained and:

Fig. 1. Variation of the components of the admittance of a longitudinal shunt slot.

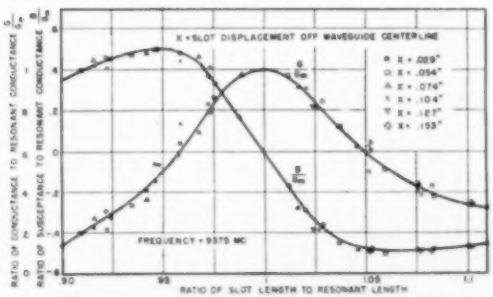
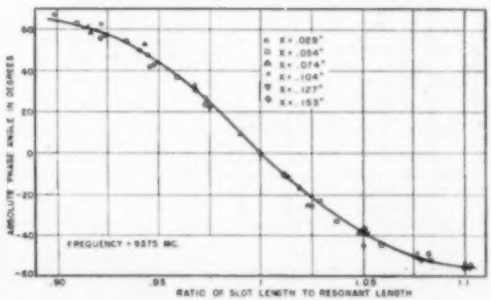


Fig. 2. Absolute phase angle of slot radiation versus the ratio of length to resonant length.



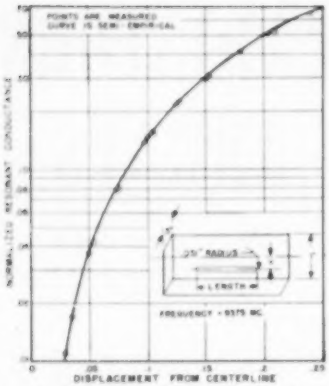


Fig. 3. Resonant conductance of longitudinal slot vs. slot displacement.

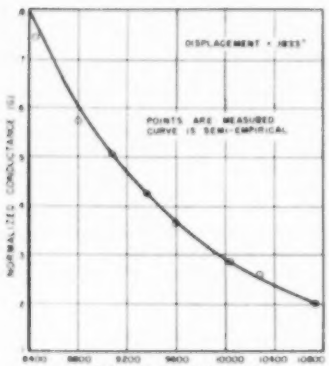


Fig. 4. Resonant conductance of longitudinal shunt slot vs. resonant frequency.

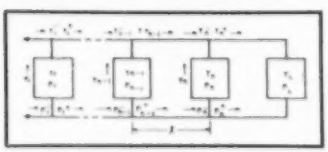


Fig. 5. Equivalent block circuit of an array of shunt elements.

$$\Phi = (2n+1)\,\pi - k\,d\cos\theta_{n+n} = 2n\,\pi - k\,d\cos\theta_{n+n} \quad . \quad . \quad . \quad . \quad (3)$$

where θ_{n+n} is the position of P_{n+n}.

For shunt slots spaced an integral number of guide wavelengths apart (neglecting guide attenuation):

$$P_r = |V|^2 G_r = K A_r^2 \quad . \quad . \quad . \quad . \quad (4)$$

Since K may be arbitrarily made equal to V^2,

$$G_r = A_r^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

and therefore:

$$G_r = G_1\left(\frac{A_r}{A_1}\right)^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

We know G_1 from slotted line measurements and A_r/A_1 from above.

Using an analysis based on Maxwell's equations, it can be shown that the ratio of the field across a longitudinal shunt slot to the total field in the wave guide is:

$$\frac{E_r}{E_i} = j\,K\,Y \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

where K is a positive real quantity. This equation shows that the field in the wave guide lags the radiated field of a resonant slot by 90°. If the wave guide field at the slot is taken as a reference, then the phase of the radiation is the phase of the admittance or:

$$\Phi = \text{arc tan}\,\frac{B}{G} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Watson[1] has shown that the admittance of a slot traverses a circle on the rectangular coordinate admittance plane as the length of the slot is varied. This circle satisfies the expression:

$$G = G_m \cos^2\Phi \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

where G_m = the maximum value of the admittance and occurs at resonance. Tests were performed on six slots, each having different displacements from the wave guide center-line.

A polar plot of measured values of G and Φ shows that the points lie on a circle which coincides with the circle defined by Eqt. (9). From these circles the maximum conductance of each slot is obtained. The points in Figs. 1 and 2 were also determined from the above measurements. It is interesting to note that the ratios G/G_m and B/G_m and the phase of the radiation are independent of the center-line displacement of the slots.

Stevenson's[2] expression for the conductance of a resonant longitudinal shunt slot in a rectangular wave guide is:

$$G_r = 2.09\,\frac{a}{b}\,\frac{\lambda_g}{\lambda}\cos^2\left(\frac{\pi}{2}\,\frac{\lambda}{\lambda_g}\right)\sin^2\left(\frac{\pi\,x}{a}\right) \quad (10)$$

where x = slot displacement off the wave guide center line.

The measurements made on longitudinal shunt slots in 1.0 x 0.5 inch (outer dimension) wave guide at 9375 mc. differed from the value obtained from (10) by the factor 0.96. The semi-empirical expression for the conductance of a longitudinal shunt slot at 9375 mc.,

$$G = 0.96\,G_r = 1.19\sin^2\left(\frac{\pi\,x}{a}\right) \quad . \quad (11)$$

is plotted in Fig. 3. Radiation measurements with a large ground plane about the slots gave essentially the same results as direct admittance measurements without a ground plane. The difference must be attributed to finite slot width and finite wall thickness. The resonant frequencies of a shunt slot were determined as the slot length was increased.

A typical curve of the resonant frequencies of a shunt slot as a function of slot length is shown in Fig. 6. The empirical curve is directly proportional to free space wavelength.

Since slot resonant length is directly proportional to free-space wavelength, a single curve of slot length as a function of displacement from the wave guide center-line will be sufficient. Fig. 7 is a plot of the resonant lengths in free space wavelength of longitudinal shunt slots as a function of the displacement off the wave guide center-line. Watson[1] has shown that for small displacements the theoretical length of a longitudinal shunt slot increases parabolically with its displacement from the center of the broad face. This is experimentally verified by this curve. Fig.

Fig. 6. Shunt slot resonant frequency vs. length.

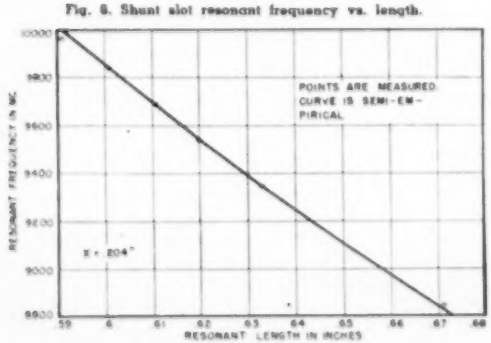
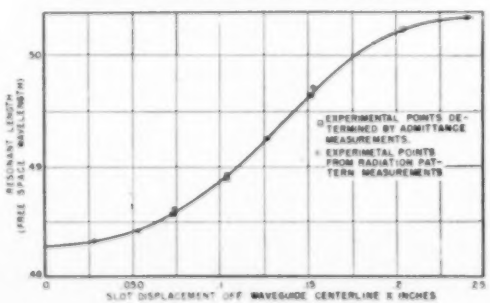


Fig. 7. Shunt slot resonant length versus displacement of the center line off the wave guide.



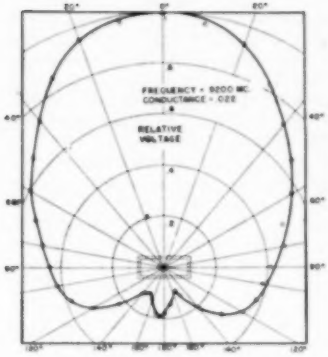


Fig. 8. E-plane radiation pattern of a low conductance longitudinal shunt slot.

4 is the conductance of a resonant slot as a function of frequency. The points are measured and the curve satisfies the equation:

$$G = 1.61 \frac{\lambda_g}{\lambda} \cos^3\left(\frac{\pi}{2} \frac{\lambda}{\lambda_g}\right). \quad . \quad . \quad . \quad (12)$$

Slot Radiation Patterns

The design of an array of shunt slots to give a specified radiation pattern requires that the radiation pattern of a single slot be known. For a shunt slot array in a straight wave guide the pattern of primary interest is the H-plane pattern. Fig. 11 is a typical H-plane pattern for a single slot. When a large ground plane was placed about the slot, the pattern was altered only by the elimination of the backward lobe. This pattern is the same as one-half of an E-plane pattern of a half wavelength wire dipole in free space. It is of interest to compare the E-plane patterns of a low conductance slot (Fig. 8), a high conductance slot (Fig. 9), and a slot with a large ground plane about it (Fig. 10). The asymmetry of the high conductance slot on the surface of the wave guide caused the radiation pattern to tilt off the normal. Symmetry in the pattern resulted when the slot was surrounded by the large ground plane. The amplitude variations in the radiation pattern are due to interference effects caused by reflections from the edges of the ground plane. The measured positions of the maximum and minimum values check very closely with those calculated from the expression:[4]

$$\theta = \arcsin \frac{n\lambda}{2d}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

which is obtained by assuming elements at the edges of the sheet having random amplitude and phase. The distance across the sheet is $2d$.

The change in the field patterns due to lateral displacement must be compensated for when designing an array using these slots in the surface of a plane wave guide. No compensation is necessary when the surface about the slot is a large ground plane.

An array of slots may be used to produce a shaped beam or a beam with the narrowest main lobe radiation pattern for a given side lobe level. Both of these types require arrays having carefully controlled aperture distributions. The relative magnitude and phase of the radiation fields required from each slot may be determined by several known methods. One may use the potential analogue method, or the equivalent analytical method discussed by T. T. Taylor and J. R. Whinnery[5], or methods such as Fourier analysis, which are less general but often adequate in particular cases. Having determined a particular set of excitation coefficients, the next parameters to decide upon are element spacing and transmission line termination. The latter usually depends on whether the elements are resonantly or non-resonantly spaced. An open circuit across the terminating slot is used with a resonantly spaced array. The spacing between elements is determined by the type of radiation pattern required and the input admittance characteristics desired. For example, to have high efficiency, a short array requires a non-dissipative termination, and for greatest bandwidth the spacing must be resonant. A long array will have a small bandwidth if resonantly spaced with either type of termination. Non-resonant spacing and matched termination give the long array very good bandwidth characteristics.

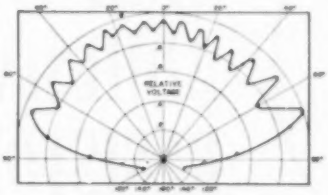


Fig. 10. E-plane radiation pattern of a slot in a 19-inch square ground plane at 9200 megacycles.

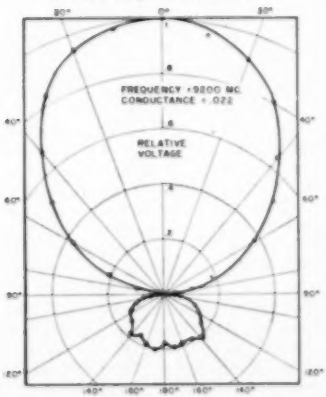


Fig. 11. H-plane radiation pattern of a longitudinal shunt slot.

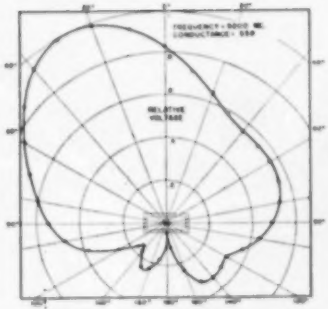


Fig. 9. E-plane radiation pattern of a high conductance longitudinal shunt slot.

Fig. 5 is the equivalent circuit of an array of shunt elements where mutual effects between the elements, except their coupling to the dominant mode, are neglected. This circuit applies very closely to longitudinal shunt slots. The array consists of n elements, the first being nearest the generator.

The exact transmission line equations are relatively complicated. However, in particular cases, these may be simplified considerably.

Resonant Spacing

For arrays with half or full wavelength spacing:

$$V_r = V_s \left[1 + \alpha l \sum_{s=1}^{s=r} s Y_{r-s}\right] \quad (14)$$

which reduces to $V_r = V_s$ for short arrays. Because:

(*Continued on page 26*)

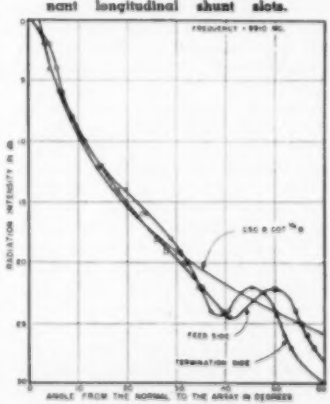
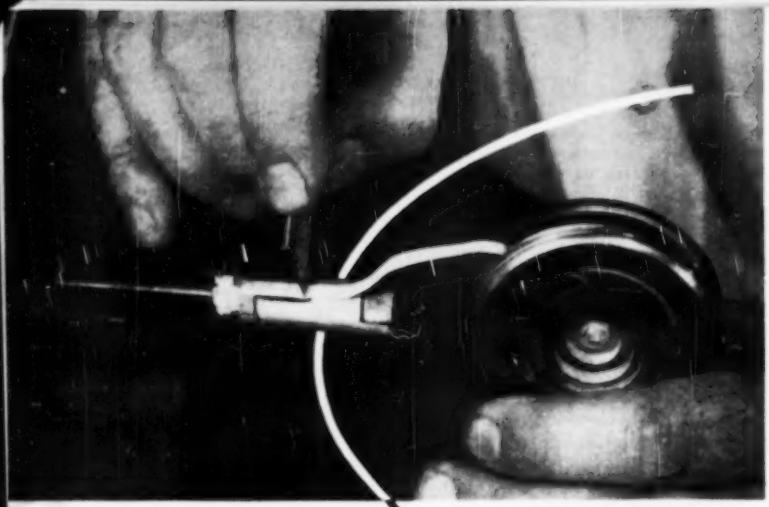


Fig. 12. Radiation pattern of a seventeen-element array of resonant longitudinal shunt slots.



One of the new NBS resistors is set in place on a miniature cylindrical chassis. It is cured by baking.

HIGH-TEMPERATURE ADHESIVE TAPE RESISTOR

This NBS development permits better control of resistors in printed circuit techniques.

PRINTED electronic circuits, in which components and wiring are superimposed directly on insulating bases, are being used increasingly because of their adaptability to economical mass production and because they facilitate miniaturization of equipment. A major disadvantage of the printed circuit method, however, has been the difficulty of incorporating satisfactory resistors in the circuits. This difficulty has been largely overcome by an adhesive tape resistor method recently devised by B. L. Davis and associates of the National Bureau of Standards. The new resistor method was developed as part of a program of electronics research and development sponsored by the Navy Bureau of Aeronautics.

In this technique, circuits are first printed in narrow metallic bands on insulating bases, leaving a small gap at each point where a resistance is required; one of the self-adhesive resistors is then cut from a strip and pressed into position. Much better control of resistance values is possible than with previous printed resistor methods, and higher yields of acceptable assemblies are assured. The new method thus appears to combine the advantages of printed resistors and of separately manufactured resistors. The NBS tape resistor was developed to withstand the high temperatures of very compact equipment and operates satisfactorily at temperatures up to 200°C; in other electrical characteristics it is similar to present film-type carbon resistors.

In the past, the usual method of introducing resistances into printed circuits has been to paint or spray a strip of resistance material directly on the base plate. The desired value of resistance is obtained by varying the composition and dimensions of the resistance strip laid down. Production of individual resistors to close tolerances by this direct-coating method is difficult, and the reduced probability of producing a number of satisfactory resistors on the same base plate greatly decreases the yield of acceptable assemblies.

Compositions and techniques used in making and applying the new tape resistors are remarkable for their simplicity. The resistor consists of a mixture of graphite or carbon black, resin, and solvent, applied in a thin layer to a thin roll of asbestos paper tape.* The resistive coating is sufficiently adhesive to stick to an insulating base plate and to make satisfactory electrical contact with metallic terminals. When the resistor is in position, the resistance film is protected from abrasion and electrical shorts by its asbestos-tape backing. Resistor dimensions are kept constant. A variety of coating formulations gives a range of values from about 100 ohms to 10 megohms.

The resistor is manufactured by spraying the resistance mixture onto a moving belt of tape. A thin (0.002 inch) protective film of polyethylene is lightly pressed over the resistance coating for protection in handling and storage; it is easily removed when the resistor is used. An electrically-driven slitting machine quickly cuts the tapes into long strips of the desired width.

At present, the resistor tape, cut to width, is applied to printed circuitry by hand from a continuous spool. The tape is pressed into position and cut off with a razor blade. Plans call, however, for development of a device comparable to a wire stapler which will accept a roll of the resistor tape and apply and cut off a resistor of standard length each time a knob or handle is pressed.

Silicone resin** is used for the binder-adhesive because of its suitability for high-temperature operation. Since the curing temperature of the silicone resin formulations is high (300°C), and since curing is done after the resistors have been positioned in the circuit, the NBS tape resistor is, at present, applicable only to glass or ceramic base materials. However, enough work has been done with lower-curing resins to indicate definitely that they can be used in making tape resistors having cure temperatures low enough for application to some heat-resisting plastic materials. These resistors would be suitable for conventional operating temperatures.

The possibility of varying resistor dimensions to obtain a range of values

*"Quinterra" tape (Johns-Manville, New York) has been found satisfactory.

**DC 996 is the preferred resin of those investigated so far.

was considered but rejected. This so-called "aspect ratio" system has the advantage of reducing the number of formulations needed for a complete resistor range, but it complicates equipment design and production. Resistor dimensions were therefore standardized at a length of 0.5 inch (0.3 inch inter-electrode distance) and a width of 0.13 inch ± 0.02 inch. This slight leeway in width permits some adjustment of resistor value in the slitting operation. With constant dimensions, wattage ratings are substantially independent of resistance value, and different contact resistance values due to different contact areas of silver and resistor are eliminated.

Both natural and synthetic graphites, as well as various carbon blacks, are used in the resistor formulations. Values of the resistors are varied by changing the ratio of carbon to resin in the mixture and by using different carbons. The proportion of carbon to resin ranges from 10 to 50 per-cent; leaner mixtures have been found to give less favorable characteristics.

Tape resistors made from graphite mixtures have proved remarkably stable at ambient temperatures of 200°C. Another advantage of graphite formulations is that unusually low resistance values, down to about 100 ohms, can be obtained. Unfortunately, however, the useful upper limit of the graphite formulations seems to be about 5000 ohms. Carbon blacks, which are less desirable at high temperatures, give values from 5000 ohms to 10 megohms. Only a few carbon blacks have been found which yield tape resistors satisfactory for operation at 200°C. For most resistance ranges, however, carbon-black tapes have been made which are satisfactory at 170°C.

The coating formulation, carbon, resin, and solvent, is agitated with porcelain balls on a ball mill for at least 72 hours before it is sprayed on the tape. Spraying is done in a special cabinet. To secure a uniform coating, the tape, in the form of an endless belt 13 feet long and 1¼ inches wide, is moved rapidly past a spray gun many times as the spray mixture is slowly deposited. A number of infrared heat lamps, mounted within a few inches of the moving tape, hasten removal of solvent during spraying and dry the tape to the desired degree of stickiness after spraying is stopped.

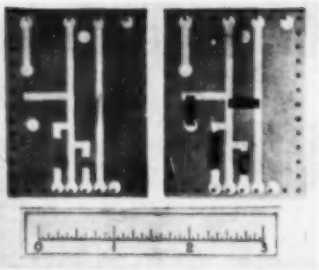
The tape-slitting machine employs 12 disk knives mounted in pairs, slightly overlapping so as to give a scissors action and separated by accurately-ground spacers. A small sample of the tape may be tested for value before the entire tape is slit. Testing is done by cutting the sample into a series of strips varying in width by 0.01 inch over the range 0.11 to 0.15 inch and making up a test plate from these strips. On the basis of test results, the slitter can be set to cut the entire roll into strips of the width necessary to give the desired final resistance value. A single belt of resistance tape yields approximately 1500 resistors.

Proper curing of the resistors after application to the printed circuitry is extremely important. The curing process hardens the resistor, bonds it more firmly to the plate, and stabilizes its electrical characteristics. Although the optimum cure for different formulations differs considerably, a compromise cure of 4 hours at 300°C has proved satisfactory and has been adopted as standard. Curing is done in a temperature-controlled electric furnace to which an aluminum inner liner has been added to secure more uniform temperature distribution.

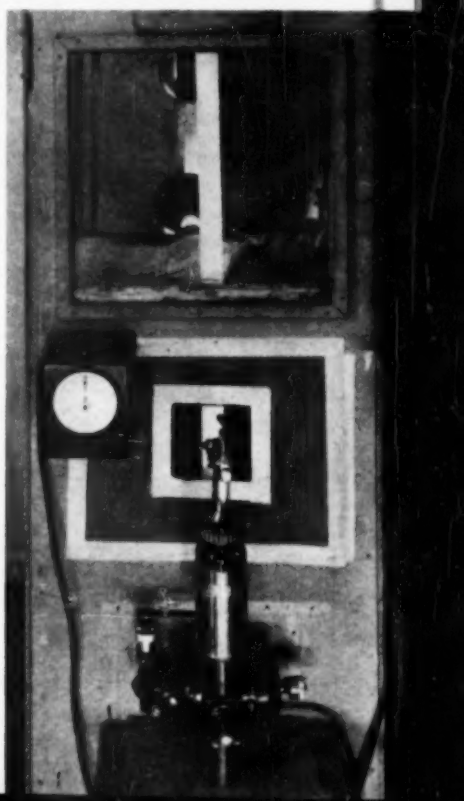
In using the resistors at 200°C, it has been found that those made from some formulations change sharply in value during the first 24 hours, then remain stable for several hundred hours. For this reason, there is some advantage in following the standard 4-hour cure at 300° with a 24-hour treatment at 200°C. As changes in the resistor film resin take place quite slowly at room temperature, the resistor tape may be stored for long periods. Its storage life may be further extended by refrigeration.

Testing and development of tape resistors are continuing at NBS. This work utilizes a test oven of special design which permits automatic recorded measurements to be made simultaneously on a large number of resistors without removal from the oven. Improved resistance formulations are being sought, particularly for certain ranges. Attempts are also being made to develop a satisfactory additional protective coating for application to the positioned resistor.

A specially designed electrically driven tape slitter cuts the tape resistor into strips of the desired width. Twelve disk knives, mounted in pairs and spaced by accurately ground spacers, overlap slightly to give a scissors action.



Typical printed circuit without (left) and with (right) the new NBS adhesive tape resistors in place. In printing the silver circuit pattern on the ceramic plate a gap of 0.3 inch is left at each point requiring a resistance. Resistors of appropriate values are then pressed into position and cured by baking the whole plate.



End view of spray cabinet in which the resistive coating is applied. A spray gun deposits the resistance formulation onto an endless belt of thin asbestos-paper tape. Infrared lamps accelerate drying. Many trips are made, assuring uniformity of coating.

A VIDEO PROBE

By

ROBERT R. RATHBONE

Servomechanisms Laboratory
Massachusetts Institute of Technology

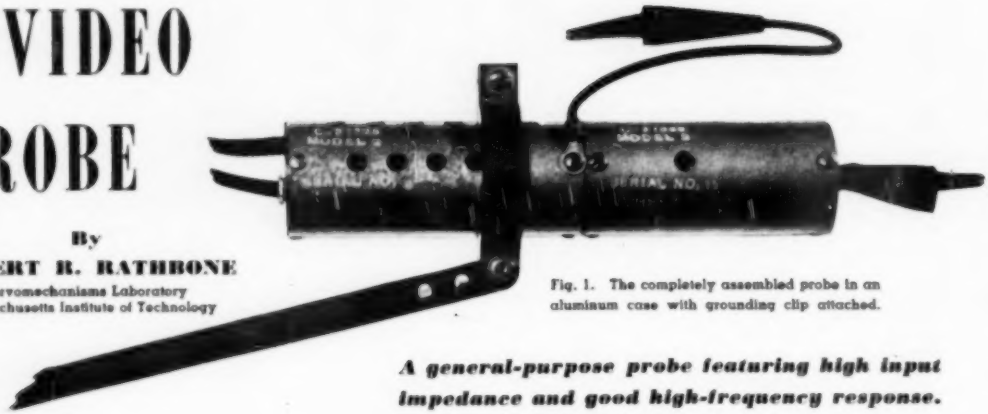


Fig. 1. The completely assembled probe in an aluminum case with grounding clip attached.

A general-purpose probe featuring high input impedance and good high-frequency response.

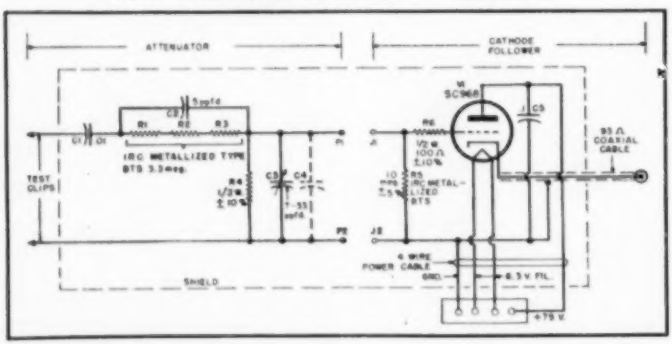
DURING THE early development and testing of the Whirlwind I electronic digital computer at the Servomechanisms Laboratory, Massachusetts Institute of Technology, trouble was encountered from stray capacitance and inductance in the cable used to connect a synchroscope to the circuit whose waveform was being observed. If the cable was unterminated, reflections and undesirable oscillations occurred, and any variation in the length of the cable during a series of observations produced inconsistent measurements; on the other hand, a terminated cable loaded the circuit under inspection.

To overcome these problems, several video probes of the cathode-follower type were constructed in the Laboratory. In general, cathode-follower probes employ an *R-C* compensated voltage divider which has a certain step-down ratio (usually 10:1 or 100:1) to provide a method of coupling from a test point to a synchroscope or video amplifier. Such probes utilize the capacitance of a coaxial cable as part of the *R-C* circuit, the cable also providing a flexible lead (of fixed length) from probe output to the input of the scope. This type of probe is useful for the observation of long pulses; however, when the pulses are about the same length as the delay time of the coaxial cable, reflections occur.

Editor's Note: This article is the sixth in a series describing the special pulsed-circuit test equipment recently developed at the Servomechanisms Laboratory, M.I.T., under the sponsorship of the Office of Naval Research. The equipment was built for the purpose of testing an electronic digital computer, but the units are sufficiently flexible in design to be valuable laboratory tools for general pulsed-circuit testing. The next article will describe the wide-band amplifier used with the video probe.

Model 2, the probe now in use, is the result of the combined efforts of many; in particular, Mr. John Ely and Mr. Harry Kenosian deserve special mention for their work on the original design. This model, shown in Fig. 1, feeds a terminated coaxial cable having a characteristic impedance of 93 ohms. The cable may be made any length up to 100 feet without introducing reflections. The cathode follower, designed to feed the cable, has low output impedance, good high-frequency response, and high input impedance. A type SC-968 triode, offering small size, high mutual conductance, and high dissipation ratings, was selected for the cathode follower, but since the tube overloads at voltages greater than one or two volts at the input, it was necessary to provide for plug-in attenuators so that a wide range of input voltages could be accommodated. The circuit schematic and parts values for both the cathode follower and the attenuator are given in Fig. 2.

Fig. 2. Circuit diagram of the attenuator and cathode follower.



It was found that the attenuators could not be sufficiently compensated when the top end of the voltage divider was shunted by a 2-$\mu\mu$fd. condenser, unless special precautions were taken. It was necessary to use three *IRC* metalized resistors (R_1, R_2, R_3, Fig. 2) in series, and to avoid overheating the pigtail leads on the resistors when soldering. These resistors, plus R_4, must be measured to within ± 1% of their rated values to insure an over-all probe accuracy of 1-2%. In all except the 1:1 and 3:1 attenuators, it was necessary to add capacitance on the lower end of the attenuator to get proper compensation (C_5, C_6, Fig. 2). One of the two condensers is variable and may be adjusted to give the proper compensation. An input capacitor of 0.01 μfd. (C_1) is connected to the attenuator to keep d.c. voltage out of the grid of the cathode follower. The value of the bottom end of the voltage divider (R_4) depends upon the values of R_1, R_2, R_3, and R_5.

The attenuator and the cathode follower are built into separate sections. Each section is encased in aluminum tubing which provides shielding against hand capacitance and pickup of stray voltages, particularly noticeable with high-impedance circuits such as exist

(*Continued on page 29*)

In this panel are illustrated standard models of HELIPOT multi-turn and single-turn precision potentiometers,—available in a wide range of resistances and accuracies to fulfill the needs of nearly any potentiometer application. The Beckman DUODIAL is furnished in two designs and four turns-ratios, to add to the usefulness of the HELIPOT by permitting easy and rapid reading or adjustment.

A B C

MODELS A, B, & C HELIPOTS
A—10 turns, 46° coil, 1-13/16" dia., 5 watts—resistances from 10 to 300,000 ohms.
B—13 turns, 140° coil, 3-5/16" dia., 10 watts—resistances from 50 to 500,000 ohms.
C—3 turns, 13-1/2° coil, 1-13/16" dia., 3 watts—resistances from 5 to 50,000 ohms.

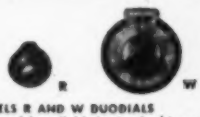
D E

MODELS D AND E HELIPOTS
Provide extreme accuracy of control and adjustment, with 9,000 and 14,400 degrees of shaft rotation.
D—25 turns, 234° coil, 3-5/16" dia., 15 watts—resistances from 100 to 750,000 ohms.
E—40 turns, 373° coil, 3-5/16" dia., 20 watts—resistances from 200 ohms to one megohm.

F G J

MODELS F, G AND J PRECISION SINGLE-TURN POTENTIOMETERS
Feature both continuous and limited mechanical rotation, with maximum effective electrical rotation. Versatility of designs permit a wide variety of special features.
F—3-5/16" dia., 5 watts, electrical rotation 359°—resistances 10 to 100,000 ohms.
G—1-5/16" dia., 2 watts, electrical rotation 356°—resistances 5 to 20,000 ohms.
J—2" dia., 5 watts, electrical rotation 357°—resistances 50 to 50,000 ohms.

LABORATORY MODEL HELIPOT
The ideal resistance unit for use in laboratory and experimental applications. Also helpful in calibrating and checking test equipment. Combines high accuracy and wide range of 10-turn HELIPOT with precision adjustability of DUODIAL. Available in eight stock resistance values from 100 to 100,000 ohms, and other values on special order.



R W

MODELS R AND W DUODIALS
Each model available in standard turns-ratios of 10, 15, 25 and 40 to 1. Inner scale indicates angular position of HELIPOT sliding contact, and outer scale the helical turn on which it is located. Can be driven from knob or shaft end.
R—2" diameter, exclusive of index.
W—4-3/4" diameter, exclusive of index. Features finger hole in knob to speed rotation.

FOR PRECISION POTENTIOMETERS come to Helipot

...world's largest manufacturer of such equipment!

For many years The HELIPOT Corporation has been a leader in the development of advanced types of potentiometers. It pioneered the *helical* potentiometer—the potentiometer now so widely used in computer circuits, radar equipment, aviation devices and other military and industrial applications. It pioneered the DUODIAL*—the turns-indicating dial that greatly simplifies the control of multiple-turn potentiometers and other similar devices. And it has also pioneered in the development of many other unique potentiometric advancements where highest skill coupled with ability to mass-produce to close tolerances have been imperative.

In order to meet rigid government specifications on these developments—and at the same time produce them economically—HELIPOT* has perfected unique manufacturing facilities, including high speed machines capable of winding extreme lengths of resistance elements employing wire even less than .001" diameter. These winding machines are further supplemented by special testing facilities and potentiometer "know-how" unsurpassed in the industry.

So if you have a problem requiring precision potentiometers your best bet is to bring it to The HELIPOT Corporation, world's largest manufacturer of such equipment. A call or letter outlining your problem will receive immediate attention!

**Trade Marks Registered*

The versatility of the potentiometer designs illustrated above permit a wide variety of modifications and features, including double shaft extensions, ganged assemblies, the addition of a multiplicity of taps, variation of both electrical and mechanical rotation, special shafts and mounting bushings, high and low temperature operation, and close tolerances on both resistance and linearity. Examples of potentiometers modified for unusual applications are pictured at right.

A C

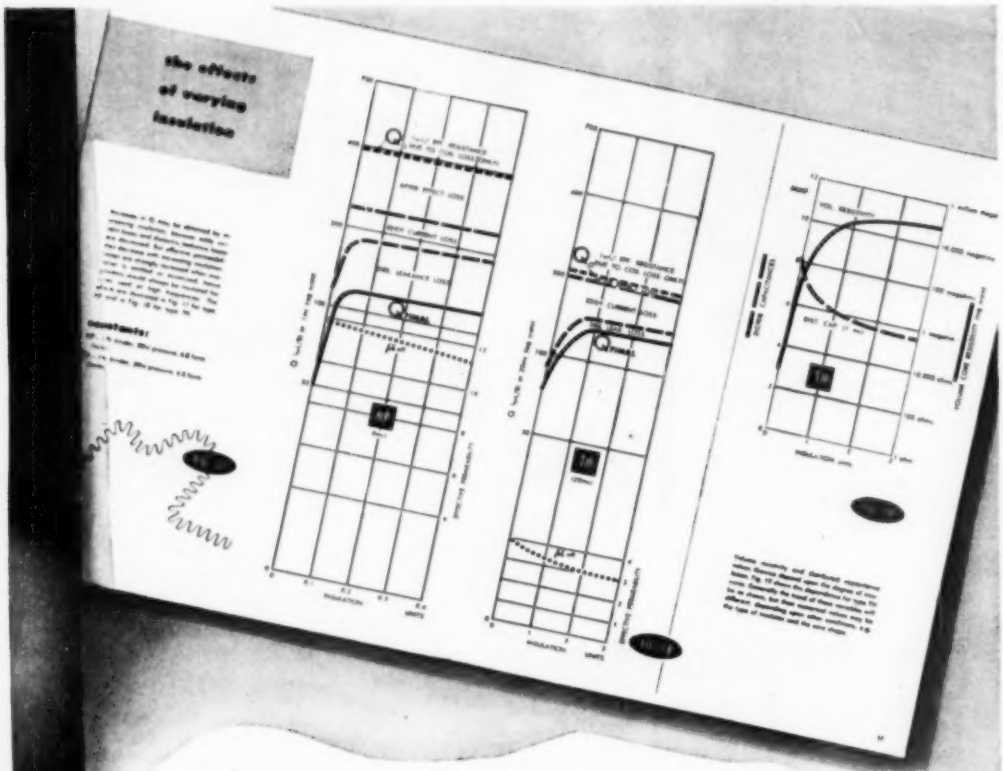
3-GANGED MODEL A HELIPOT AND DOUBLE SHAFT MODEL C HELIPOT
All HELIPOTS, and the Model F Potentiometer, can be furnished with shaft extensions and mounting bushings at each end to facilitate coupling to other equipment.
The Model F, and the A, B, and C HELIPOTS are available in multiple assemblies, ganged at the factory on common shafts, for the control of associated circuits.

B F

MULTITAPPED MODEL B HELIPOT AND 6-GANGED TAPPED MODEL F
This Model B Helipot contains 40 taps, placed as required at specified points on coil. The Six-Gang Model F Potentiometer contains 19 additional taps on the middle two sections. Such taps permit use of padding resistors to create desired non-linear potentiometer functions, with advantage of flexibility, in that curves can be altered as required.

THE Helipot CORPORATION, SOUTH PASADENA 4, CALIFORNIA

Field Offices: Boston, New York, Philadelphia, Rochester, Cleveland, Detroit, Chicago, St. Louis, Los Angeles and Fort Myers, Florida. Export Agents: Frotham Co., New York 18, N.Y.



G A & F Carbonyl Iron Powders are unique . . . This new book is unique . . . Here is the most comprehensive treatment ever given to the characteristics and applications of Carbonyl Iron Powders. (The 3-page bibliography alone is a valuable addition to your reference library.)

This book was written for the manufacturer or engineer who wants a maximum of facts with a minimum of verbiage. 80% of the story is told with photomicrographs, diagrams, performance charts and tables. Established applications are fully covered; new applications are suggested. Ask your core maker, your coil winder, your industrial designer, how G A & F Carbonyl Iron Powders can improve the performance and reduce the cost of the equipment you manufacture. Write us — without obligation — for your copy of this new book. Kindly address your inquiry to Dept. 16.

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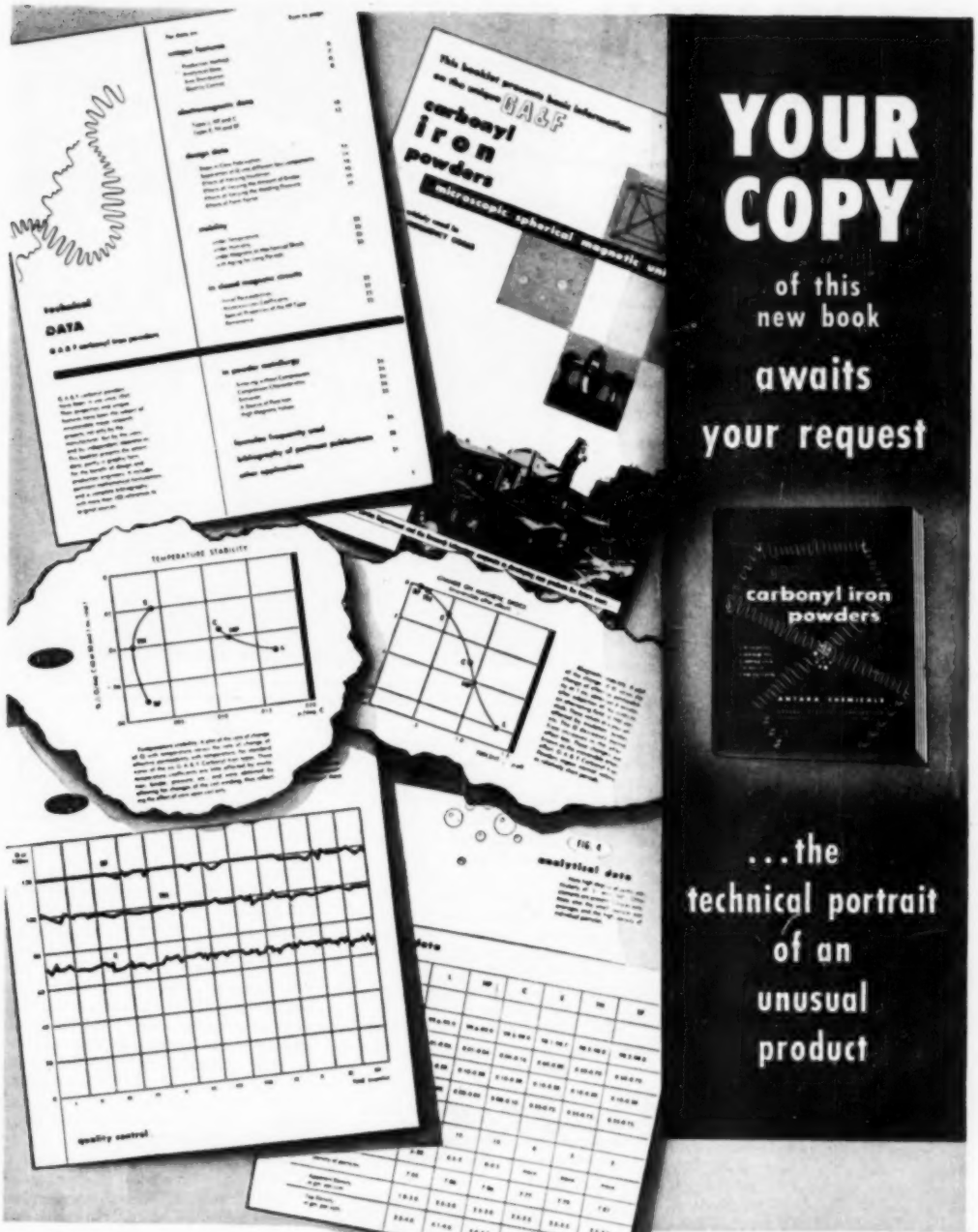
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...the technical portrait of an unusual product
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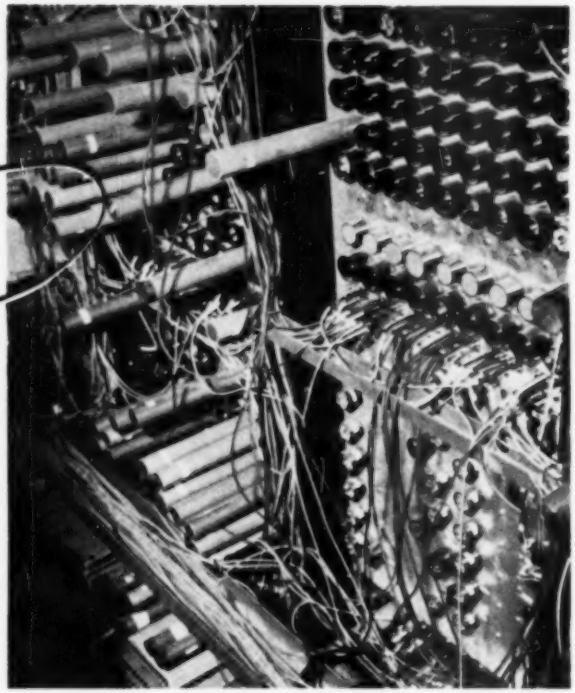
GERMANIUM DIODE EXPERIENCE

Performance of the 16,000 germanium diodes used in the NBS SEAC computer.



A group of base-mounted diodes and associated cabling, part of the 16,000 diodes used in the NBS Eastern Automatic Computer.

UNITED STATES production of germanium diodes for radio and electronic applications has expanded to something like 4 million a year. Yet because they are relatively new, germanium diodes have not received extensive service study, and few significant data on their characteristics in extended use have become available. Because it uses some 16,000 germanium diodes for computing and switching functions, with the requirement of very high reliability, the National Bureau of Standards Eastern Automatic Computer (SEAC) is a natural proving ground for the diodes. Of interest, therefore, is a recent preliminary study of experience with germanium diodes in the SEAC program. Conducted by J. H. Wright of the NBS electronic computer laboratory, the study is based on data compiled during the electronic computer's first six months of operation after its dedication in June 1950.

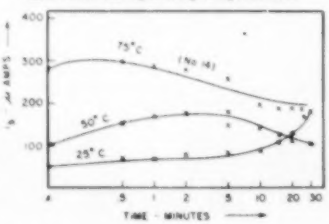
Reliability is the outstanding requirement of diodes in computer use. Even momentary failure of a single one of SEAC's diodes will cause computer misfunction.

In view of this severe requirement, germanium diode experience in the SEAC program has been gratifying. After some 2500 hours under voltage, only about 5.4 per-cent of the diodes initially in service had had to be replaced, rest of the replacements being because of back current drift, or "creep". The great majority of these replacements were made in the course of routine maintenance checks before the questionable diodes could cause computer misfunction. Also encouraging, the rejection rate for the several thousand diodes purchased in the last six months of 1950 was less than 2 per-cent. Moreover, diode quality has undoubtedly improved since SEAC's first diode purchases were made, and continued improvement seems likely.

SEAC circuitry was designed to use diodes of a single specification, the 50 volts (back) 50 milliamperes (forward) type. A design value of -40 volts was selected as being the absolute limit of back voltage that would be encountered, and 20 ma. was chosen arbitrarily as the peak forward current.

Each diode must be individually tested before use in SEAC; spot checking is inadequate, since all weak links must be excluded. Tests are made twice before a diode goes into service, once before soldering into position and once after. Equally important to reliable computer function are the preventive maintenance checks made at regular intervals on diodes already in service.

Back current drift with time of an individual "creeper" diode recorded at three different operating temperatures.



SEAC diodes are tested for back current at -40 volts and for forward voltage drop at 20 ma. forward current, the design maxima. For a "normal" diode, *i.e.*, one that does not "creep" appreciably, permissible back current at -40 volts is specified as 250 μa. before soldering, 300 μa. after soldering, and 500 μa. for units in service. For a "good creeper", corresponding rejection limits are 120, 200, and 300 μa. (A "good creeper" is defined as one that drifts less than 50 μa. and stabilizes markedly in the ½ minute observation period.) Rapid "wigglers" (rapidly-fluctuating creepers, with periods of less than a second) must not exceed plus or minus 10 μa. fluctuations. Maximum permissible forward voltage at 20 ma. is 2.0 volts before or after soldering and 2.3 volts for units in service. Fixed forward current was specified rather than fixed voltage, partly because SEAC's gate circuits are current operated, and partly because the fixed-current test circuit is short-circuit proof.

Deterioration of back characteristics has been the chief reason for SEAC diode replacements; and excessive creep has been a much more frequent reason for replacement than excessive back current. Excessive creepers are replaced because of their unpredictability, although creep of itself will not necessarily cause computer misfunction. Creep in back current was observed in a substantial percentage of the commercially available diodes tested for SEAC, including both the wax-imbedded types and the hermetically-sealed types without the wax embedding. The incidence of creep varied between makes, however, as well as from batch to batch. Forward characteristics, unlike back characteristics, deteriorated very little; and the number of complete failures such as shorts and opens was negligible.

Creepers vary widely in their behaviour. Initial creep may be in the direction of either increased or decreased current, while the long-term trend may bear no relation to the initial trend. Initial downdrifters are at present considered as undesirable as updrifters, since either seems likely to rise to excessive currents in the course of time. Creep may be gradual and steady, perhaps ultimately leveling off. Or, as more often happens, it may be more or less periodic, the period varying widely from less than a second ("wigglers") to a number of minutes or even hours.

It now seems clear that diode creep is not caused to any appreciable extent by imperfect mechanical contact. Although moisture is suspected of playing some role, it appears unlikely that some of the observed creep phenomena could be caused by moisture alone.

In addition to the observations on diodes in regular service, a few experiments were made. To study the effect of operating temperature on creep, 29 creepers were tested at 25° and 75° C. Although individual units differed, these experiments indicate that drift is not notably aggravated by increase in temperature within the usual range.

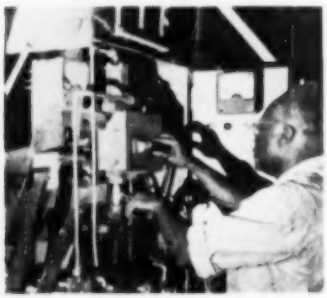
Another group of 18 creepers was studied for 210 hours at room temperature in an effort to determine whether an observation of one minute or less is sufficient to exclude long term creepers. These limited data indicate that one-minute or ½ minute observations, holding to a 300 μa. limit, satisfactorily exclude those units which would later drift beyond 500 μa.

The SEAC diode experience study indicates a definite need for more life data and better specifications for germanium diodes for computer applications. NBS investigators have outlined data-compilation and specification projects which they hope will be undertaken cooperatively by computer groups and other interested diode users.

NEWS BRIEFS

HEAT-DETECTING MACHINE

An electric-eye unit that literally sees heat is helping in the production of electronic tubes in the *General Electric*



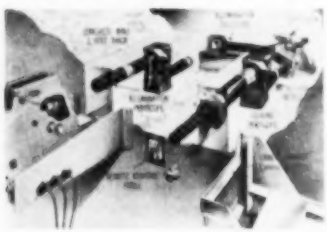
Company's Industrial and Transmitting Tube Plant, Schenectady, New York.

Controlling temperature of glowing graphite crucibles that give off a dazzling white light too intense for eye safety, the electric eye unit can be used to control temperatures ranging upward from 2000 degrees Fahrenheit, with only a 15-degree leeway in accuracy, by adjusting it to register gradations in color from a dull red right through the "hot-color" spectrum, to the brightest white.

The changes in color and intensity, from small tube parts that are fused in the crucible, react on the photoelectric tube in the electric eye, setting off a reaction that controls the crucible temperature at a critical point.

RADIOACTIVE DETECTION DEVICE

The first of its kind, a new instrument can now safely study and photo-



graph deadly radioactive materials, it was jointly announced by *American Optical Company's* Instrument Division, Buffalo, New York, who built the device, and the *General Electric Company*, Schenectady, New York.

The instrument is a special microscope for examining the structure of metals, combined with camera, periscopes, and an illuminating system, in such an arrangement that light can get in and out through the thick walls of the test chamber, but nuclear radiations from the radioactive specimens are completely blocked. Operating by remote control, the instrument permits atomic researchers to work in complete safety, and will make possible investigations never before accomplished on the effects of radiation damage to materials.

ELECTRONICS CENTER

In a plan revealed by the *General Electric Company*, Syracuse, N. Y., and Cornell University for the establish-

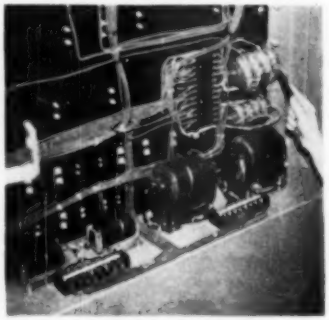
ment of an advanced electronics center at Ithaca, New York, projects may include development of such items as control systems for guided missiles, electronic countermeasures, and infrared systems.

The project will be known as the *General Electric* Advanced Electronics Center at Cornell University and its activities will be directed by a four-man management team—two from industry and two from science, representing fully with their combined skills and experience, the abilities required in scientific, industrial, military, and academic aspects of such a pioneer venture.

The over-all purpose of the project, as outlined by *GE* and Cornell officials, "is to carry out advanced study and development in the field of electronics, and at the same time provide scientists and engineers with teaching and educational opportunities."

MAGNETIC AMPLIFIER REGULATOR

Tested under simulated operating conditions by *Westinghouse Electric Corporation*, 306 Fourth Ave., Pittsburgh, Pa., a magnetic amplifier regulator has successfully controlled a 4000-hp double-armature motor that will be

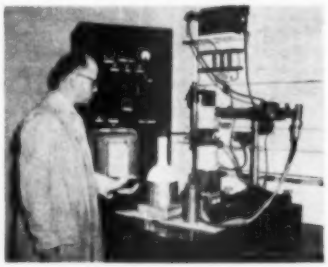


used on a 66-in. tandem cold reduction mill.

This amplifier is a static device, having no bearings, brushes, or moving parts, and can be mounted on panels in control cabinets. Its operation is analogous to that of the three-element vacuum tube, and consists of two sets of coils wound on a magnetic core. Obtaining wide ranges of speeds, it maintains the speed constant for any given control setting.

PHOTOELECTRIC INTERFEROMETER

A recording photoelectric interferometer, recently developed by Dr. R. N. Work of the National Bureau of Standards, greatly simplifies the determination of transition temperatures in natural and synthetic rubbers and high polymers, observing and plotting varying length of a polymeric sample against



temperature over the range from −185°C to +185°C.

The new interferometer was devel-

oped in connection with a program under way at NBS, which has as its object the design of new polymers having specified characteristics. An important phase of the program is being sponsored by the Office of Naval Research, relating to the development of low-temperature rubbers for use in the arctic or in high-altitude flight.

The NBS photoelectric interferometer is particularly well adapted to survey work where transitions must be located rapidly in a large number of materials. The data can be processed with a minimum of effort, and a precision of $\pm 0.5°C$ or better in the location of transition points can be realized. Values of coefficient of expansion thus obtained for rubberlike materials are reproducible to at least $\pm 5\%$.

MAJOR SMPTE AWARDS

Earl I. Sponable, Technical Director of *20th Century-Fox Film Corporation*, was signally honored by the Society of Motion Picture and Television Engineers at its 70th Semi-annual Convention in Hollywood, California.

Mr. Sponable, Past President of the SMPTE, received both the society's Progress Medal and the Samuel L. Warner Memorial Award, for his outstanding contributions to the technical advancement of the motion picture art, particularly in the fields of sound-on-film, color film, and large-screen television.

Joining the Fox Film Corporation in 1926, he designed and built the first sound motion picture studio, assisted in developing commercial sound motion pictures, participated in creation of the first sound newsreel and has become a leader in the pioneering development of equipment and techniques for large-screen theatre presentation of televised program material.

TELEVISION TEAMWORK

Speaking before a joint branch meeting of the AIEE and the IRE at Rensselaer Polytechnic Institute, Dr. W. R. G. Baker, *General Electric Company's* Vice President, said that television industry team work will provide the country with a compatible color television system.

He pointed out that work similar to that now being carried on by the National Television System Committee for color television, resulted in the development of standards for black and white television over a decade ago. Citing the committee's work as a prime example of teamwork needed from modern engineers, he further stated that greater-than-ever engineering opportunities are afforded today in the engineering field which has as its goal the improvement of man's standard of living.

THEATRE TV

Occupying a relatively small amount of space in the projection booth of the *RKO Fordham Theatre*, Bronx, New York, this compact control and monitoring rack is operated by the theatre's projectionist, and is used to present

full-sized TV images on the theatre's screen.

The *Radio Corporation of America*, Camden, N. J., instantaneous theatre television system is equipped with an optical unit which projects the television program, and is mounted on the front of the balcony.

ENGINEERING OPPORTUNITIES

The Rome Air Development Center has Civil Service openings for electronic engineers and scientists at salaries ranging from $3410 to $7040 per annum. Grades are determined by training and experience.

Occupants of these positions will be engaged in applied research, development and tests of electronic air-ground systems.

Send full details of your education, experience, age, and salary requirements to "Employee Utilization Section, Civilian Personnel Branch, Rome Air Development Center, Rome, New York."

TWO NBS APPOINTMENTS

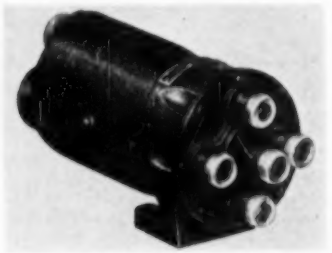
The National Bureau of Standards, Washington, D. C. has appointed Alan J. Hoffman, former member for the Institute for Advanced Study, Princeton, N. J., to its staff in the division of applied mathematics. Dr. Hoffman will work in the Computation Laboratory of the division, responsible for compiling mathematical tables and developing improved techniques for numerical com-

(*Continued on page* 29)

NEW PRODUCTS

R.F. SWITCH

A single-pole, 4-position coaxial r.f. switch, for applications at radar frequencies, is being offered by *Transco*



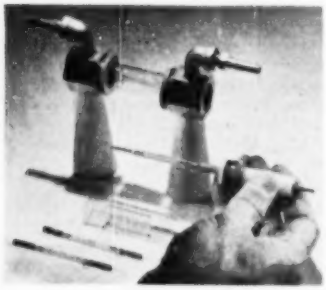
Products, Incorporated, along with various models for aircraft applications requiring performance under extreme temperature and shock conditions.

Performing at a frequency range up to 11,000 mc., a VSWR less than 1.5, and external features of compactness for easy installation, all r.f. switches have been built according to MIL specifications.

Further information may be obtained from *Transco Products, Inc.*, 12210 Nebraska Ave., Los Angeles 25, Calif.

HIGH-INTENSITY LIGHT

Mercury arc lamp and water-jacket components have been redesigned by the *Huggins Laboratories*, Hamilton Ave., Menlo Park, Calif., to provide arc widths of 1, 1¼, and 1½ mm. Having approximate power inputs ranging

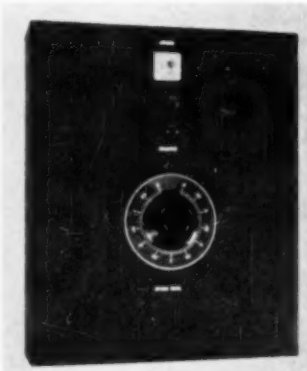


between 1 and 2 kw., brilliances from 40,000 to 90,000 candles per square centimeter, and light outputs from 65,000 to 130,000 lumens, the high-intensity light can be operated from a.c., d.c., single-flash, or stroboscopic power supplies, and can be provided with all-quartz accessories where a powerful source of ultraviolet is needed.

High speed and stroboscope photographs, optical apparatus, photosynthesis, and photochemical processes, as well as specialized procedures requiring unusual brilliance in either the visible or ultraviolet light spectrum, are included in its applications.

VARIABLE DELAY LINE

The distributed-parameter, continuously variable delay line offered by *Advance Electronics Company*, P. O. Box 394, Passaic, N. J., is capable of providing a continuously variable time delay from zero to 0.6 microsecond.



It has complete freedom of time jitter, fast rise time, limitless repetition frequency, greater bandwidth, and good transient response. Type 302 includes among its applications accurate distance measurements in radar or loran systems, for establishing coincidence of sweep and input signal in high-speed oscilloscopes, and for measuring time intervals with accuracy better than a small fraction of a microsecond.

TOROIDAL CORES

Molded powdered-iron toroidals, produced by *Lenkurt Electric Company*, 1115 County Road, San Carlos, Calif., range in sizes of 0.800 to 3.375 inches outside diameters. Available in magnetic materials which accentuate high-Q, high inductance, low generation of harmonic distortion products, and high

magnetic and temperature stability, these cores are also supplied wound to individual specifications, cased, uncased, or hermetically sealed.

CURRENT STABILIZER

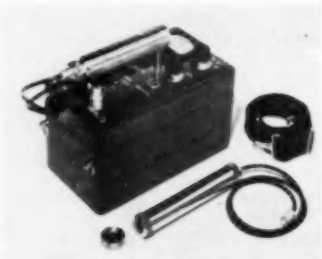
Designed to hold tube current constant at any given setting when used in conjunction with water-cooled x-ray diffraction equipment, the new *Norelco* MA Stabilizer has three ranges, 0.5 to 2 ma., 7 to 25 ma., and 25 to 50 ma.

The stabilizer developed by the *North American Philips Company, Inc.*, 750 S. Fulton Ave., Mt. Vernon, N. Y., selects the three stages by means of a three-positioned lever switch mounted on the end of the stabilizer chassis and is provided with safety circuits which protect the x-ray tube filament from excessive heating.

A mechanical stop is also provided on the variable auto-transformer to assure sufficient x-ray tube voltage.

SURVEY METER

A new Alpha Beta Gamma Survey Meter with an optional probe for alpha detection, has been developed for use as both a radiation dosage rate meter and a low-level contamination monitor. The SU-5A, manufactured by *Tracer-*



lab, Incorporated, 130 High St., Boston 10, Mass., can be used for checking

glassware, benchtops, hands, coats and locating small amounts of spilled radiochemicals, in addition to locating radium, and measuring dosage rates from stored radioisotopes, to ascertain whether adequate shielding has been employed.

Waterproof, lightweight, battery operated and provided with two sets of scale ranges, it is equipped with a P-17 side window probe which permits the separate measurement of gamma radiation in the presence of beta radiation.

LABORATORY MONITOR

Known as the "Radiation Sentinel," a new laboratory monitor has been

announced by *Nuclear Instrument & Chemical Corporation*, 223-233 West Erie St., Chicago 10, Ill. Model 1615A is equipped with a four-inch meter and a selector switch which permits the meter to indicate either count rate or Geiger tube voltage.

Included in the Radiation Sentinel is a built-in power supply, a switch for a chart drive recorder, and a magnetically mounted probe which permits the thin mica window counter to be mounted on any iron or ferromagnetic object for monitoring vacuum lines, bench top surveying or clinical and therapeutic checking.

AIRBORNE AUDIO AMPLIFIERS

The production of airborne audio amplifiers, developed primarily for PA and entertainment use aboard aircraft, has been started by *Gertsch Products, Inc.*, Los Angeles, Calif.

The two Models AA-1A and AA-1B, identical in appearances and differing only in their input power requirements, include variable frequency response by means of a 4-position filter for noise suppression, remotely operated HI-LO level control, and dual input circuits.

MINIATURE COUNTER DECADES

The Potter Instrument Company, 115 Cutter Mill Road, Great Neck, N. Y., announces a new miniaturized, redesigned version of the four-tube Electronic Counter Decade, available in two models which differ only in the maximum counting capabilities.

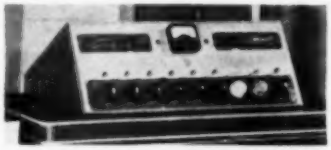
The Model 12 is designed for counting at rates up to 130,000 counts per-second, and the Model 13 for counting at rates up to 30,000 counts per-second. Equipped with a binary decimal coding system (1-2-4-8), it is easily adaptable to computer circuitry and recording devices using four styli.

The new decades are available with either a remote panel-mounted four-lamp readout or with a small plug-in neon cluster on the decade frame for applications in which the indicators serve only for tube servicing.

STUDIO CONSOLETTE

Providing a flexible speech input system for AM, FM and TV broadcast stations, an improved consolette (*RCA* Type BC-2B) has been announced by the *RCA Engineering Products Department*, Camden, N. J.

Besides offering control facilities for one or two studios, it serves an announce booth, a control room microphone, two turntables, a network, and five remote lines. The frequency response from any input to the line output is within plus or minus 1.5 db from 30 to 15,000 cps. The total rms harmonic distortion is less than .5 per-cent from 50 to 15,000 cps at a line-output level of 18 dbm. The new consolette has a total power input requirement of 150 watts, 50 to 60 cps a.c., and 105 to



125 volts. It weighs approximately 114 pounds and has over-all dimensions of 11¼ inches high, 33 inches wide, and 21⅛ inches deep.

Further information may be obtained from the *RCA Engineering Products Department*, Camden, N. J.

A.C. VOLTAGE REGULATOR

With an accuracy of 0.01%, the Model 1001 A.C. Line Voltage Regulator is of importance to techniques demanding a.c. line regulation of unusual accuracy.

This new unit, manufactured by *Sorensen & Co., Inc.*, Stamford, Conn., also offers a combination twist-lock and double-T receptacle; three-function output switch for (1) normal regulator functioning, (2) operation with integral semi-fixed resistance in place of poten-

(*Continued on page* 29)

Personals

NICHOLAS E. GOLOVIN has been named Assistant Director for Administration of the National Bureau of Standards, which will include planning and management functions for technical programs. Mr. Golovin, who received his M.A. in mathematical physics from Columbia University, previously was head of the Management Division at the Naval Ordnance Test Station, California, and Associate Superintendent at the Naval Research Laboratory.

DR. VICTOR S. HICKS, newly appointed Chief Physicist of *Tracerlab, Incorporated*, will direct many research and development projects. He received his A.B. from Williamett University in 1925; his M.S. from the University of Washington in 1927; and his Ph.D. from the University of California in 1930. Dr. Hicks is a member of many scientific societies, among them the American Physical Society and is the author of many technical papers in the field of physics.

JAMES C. P. LONG has joined the engineering staff of the *Sprague Electric Company*, it was announced by Julian K. Sprague, Vice President. Formerly head of the Material Coordination Section of the Bureau of Aeronautics, U. S. Navy Department, he also served as a member of the RDB's Panel on Components. Mr. Long is a graduate of Grove City College, Grove City, Pennsylvania and served in the Navy as a Lieutenant from 1943 to 1946.

C. J. LUTEN was appointed Editor of the Service Dealer magazine for *Sylvania Electric Products Incorporated*. He previously served as a director of educational advertising, an assistant editor to an employee magazine, and a reporter for the Dallas Times Herald. Mr. Luten graduated from Southern Methodist University and was the recipient of the 1944 Sigma Delta Chi Award, naming him outstanding journalism graduate of his class.

DR. LOUIS N. RIDENOUR has been appointed Director of Engineering for the *International Telemeter Corporation*. A graduate of the University of Chicago and California Institute of Technology, he served with Massachusetts Institute of Technology during the war and played an important part in the development of microwave radar, helping its introduction into airforce operations. His new duties will be connected with technical developments of the Telemeter System.

OTTO H. SCHADE, nationally-known scientist of the *Radio Corporation of America* Tube Department, became the first recipient of the David Sarnoff Gold Medal Award, conferred on him at the 70th Semi-Annual Convention of the Society of Motion Picture and Television Engineers. The award was given in recognition of his development of rating methods for measuring the picture-reproducing quality of 35mm film and television systems mathematically.

Slot Radiators

(*Continued from page 13*)

$$P_r = |V^2| G_r \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

$$G_r = G_s \frac{P_r}{P_s} = P_r \frac{\sum_{r=1}^{n} G_r}{\sum_{r=1}^{n} P_r} \quad . \quad . \quad . \quad (16)$$

The input admittance to this array is:

$$Y_{in} = \sum_{r=1}^{n} G_r + j \sum_{r=1}^{n} B_r \quad . \quad . \quad (17)$$

In general, the input admittance is designed to be either unity or a large real value (overloading). These and other values are easily attained; other values may be more desirable in certain cases.

A radiation pattern of a resonantly spaced array of 17 resonant slots is shown in Fig. 12. The theoretical curve of $\csc \theta \cot^{1/2} \theta$ was designed from 3° to 45°. The measured pattern and the theoretical curve show less than 3 db deviation from 2° to 55°. Machining tolerances can easily explain the departure of the radiation pattern from the theoretical curve, especially with the large (1860:1) range of radiated powers required.

Fig. 13 is the radiation pattern of a 15 element array of non-resonant slots. The theoretical curve of $\csc^3 \theta \cot^{1/2} \theta$ was to be duplicated by the array for 6° to 60°. The results of the pattern measurements indicate a variation of less than 3 db from 1.5° to 61°.

Non-resonant Spacing

Interelement spacing, other than resonant, has the advantage that with a matched termination and elements having small admittances, the input admittance to the array will be near unity at all frequencies except in the vicinity of the resonant spacing frequencies. The reason for this matched condition is that the reflected waves from the elements are small and add together with effectively random amplitude and phase (because of the non-resonant spacing) at the input to the array. The voltages for a lossless transmission line are:

$$V_{r-1} = V_r \ (\cos \beta l + j Y_r \sin \beta l) \quad (18)$$

$$V_r = V_{r-1} (2 \cos \beta l + j Y_{r-1} \sin \beta l) - V_{r-2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

These expressions show that the magnitude and phase of the voltage at the rth element are functions of both the distance between elements and the admittance introduced at the $(r + 1)$ element. For the usual case of slots spaced about a half guide wavelength apart and the reflection coefficients small we have:

$$P_r = P_{r-1} (1 + 2 \alpha l). \quad . \quad . \quad . \quad . \quad (20)$$

$$Y_r = \frac{Y_{r-1} \cos \beta l + j \sin \beta l}{\cos \beta l + j Y_{r-1} \sin \beta l} \quad . \quad . \quad (21)$$

This admittance equation may be solved very quickly by use of the Smith Admittance Chart. The reflection coefficient at the rth slot is:

$$\Gamma_r^+ = \Gamma_{r-1}^- e^{-\alpha} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

This shows that only the amplitude of the reflection coefficient is altered by transmission line attenuation. If it is necessary to take attenuation into account, this expression may be used.

From the equivalent circuit it follows that:

$$G_r = G_r^+ \frac{P_r}{P_r^+} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (23)$$

so that all the G_r may be readily determined. The phase of the admittance of each slot is determined by the required phase and the phase error in the voltages due to transmission line loading. If the admittances of the slots are small, the phase error in the voltages will be small and, in some cases, may be neglected.

A 24 element array of slots was calculated to give a Tchebyscheff aperture distribution. The side lobe level was to be 30 db below the main beam. The excitation coefficients are all real for a Tchebyscheff array so that by using low conductance slots the phase error in the voltages could be neglected. The array was therefore designed with resonant slots. The spacing was greater than a half wavelength to improve the impedance characteristics. A matched termination was used. The VSWR characteristics are shown in Fig. 14. The half power beam width at the design frequency of 9375 mc. was the same as the calculated value. The beam width varied from 4.2° to 3.4° over the band from 8500 mc. to over 10,100 mc. The beam width is inversely proportional to the aperture in wavelengths. The main beam scanned 12.4° over this same band, being 2° from the normal at the design frequency. Over this same frequency range, the side lobe levels in the plane of the axis of the array normal to the surface of the wave guide were below 26 db. Four off-axis, secondary beams occurred which were 19 to 22 db below the main beam. A restrictive horn along the length of the array removed the secondary lobes, raising the side lobe level about 1 db. In a two dimensional array of these slots, the secondary lobes would not appear.

The author wishes to acknowledge the influence of discussions with R. H. Reed, the theoretical work of J. R. Miller and the non-resonant slot experimental results of T. T. Taylor, W. G. Sterns, and R. A. Henschke.

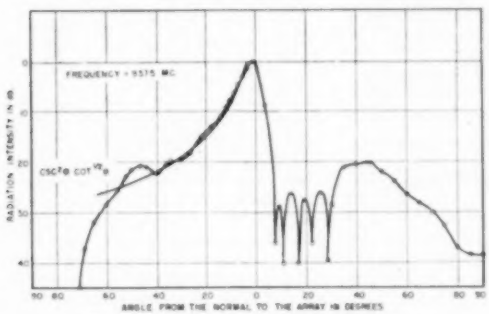
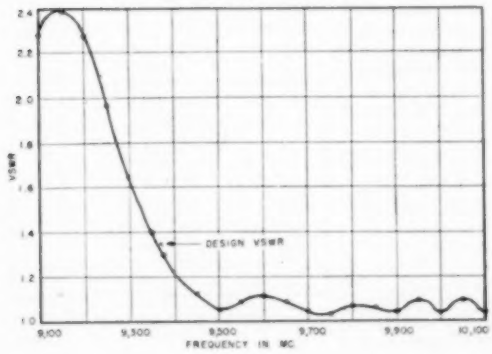


Fig. 13. Radiation pattern of 15 element array of non-resonant longitudinal shunt slots.

Fig. 14. Input VSWR of 24 element array of resonant longitudinal shunt slots.



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1. *Watson, W. H., "The Physical Principles of Waveguide Transmission and Antenna Systems," Oxford University Press, London, 1947, p. 95.*

2. *Stevenson, A. F., "Theory of Slots in Rectangular Wave Guides," Journal of Applied Physics, Vol. 19, 1948, pp. 24-38.*

3. *Watson, W. H., op. cit., p. 200.*

4. *Reich, H. J., "Very High Frequency Techniques", Vol. I, Harvard RRL Series, McGraw-Hill Book Company, Inc., New York, 1947, p. 174.*

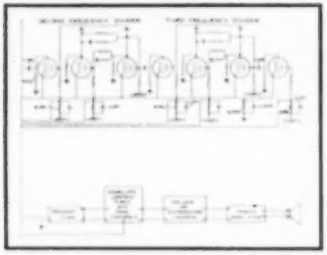
5. *Taylor, T. T. and Whinnery, J. R., "Applications of Potential Theory to the Design of Linear Arrays," Journal of Applied Physics, Vol. 22, 1951, pp. 19-29.*

PATENT REVIEW

Printed copies of these or any other patents may be obtained from the U. S. Patent Office for 25c each. Address the Commissioner of Patents, Washington 25, D. C.

ELECTRICAL MUSICAL INSTRUMENT

Improving tone quality produced by electrical musical instruments, and means for producing electrical signals corresponding to musical tones of a de-



sirable quality, are the objects of this invention.

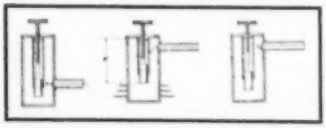
With the apparatus of this device, the rectangular wave output of the frequency divider is rectified to a very narrow pulse whose width is small in comparison with its period. All of the low order harmonics are then present in substantially equal amplitude, with this equality continuing to higher harmonics if the pulse is sufficiently narrow.

The solo oscillator is comprised of triodes having a resonant tuning circuit, and is keyed by connecting a suitable inductance into the circuit to give the correct frequency.

Patent No. 2,562,908 was issued on August 7, 1951 in the name of J. M. Hanert.

UHF LOAD DEVICE

The principal object of this invention is to provide an improved tunable load device for high frequency systems, en-



abling the device to dissipate large amounts of power, and eliminating the disadvantages of "burn-outs" and ceramic insulation cracking which occurs in some systems in present use.

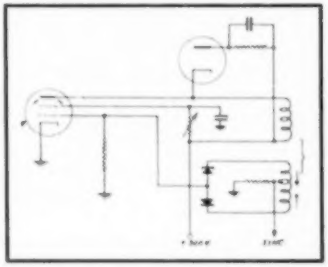
The device consists of a tunable ultra-frequency resonant cavity which is connected to a highly resonant transmission unit, the cavity being so designed and adjusted that r.f. power from the line is transmitted into the cavity and is dissipated therein in the form of heat. This is accomplished by tuning the cavity to resonance and coupling the line to a part having an impedance characteristic equal to the surge impedance of the transmission line.

Patent No. 2,562,921 was issued on August 7, 1951 in the name of A. G. Kandoian.

SWEEP GENERATOR

Relating to coil circuits, saw-tooth wave generating devices used to excite them, and to cathode-ray tube deflection circuits, this invention discloses a method for maintaining linearity in magnetic deflection systems.

The sweep generator introduces an automatic controlling voltage which either retards or accelerates devia-



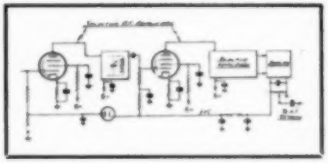
tions from given rates of change in the deflection voltage, and provides a deflection circuit containing fewer components than before believed necessary. It also initiates a self-oscillating saw-tooth type deflection voltage generator, the output of which is directly applied to the deflection coils of a cathode ray oscilloscope.

Patent No. 2,562,941 was issued on August 7, 1951, in the name of L. W. Parker.

AVC CIRCUIT

This invention presents an improved arrangement for protecting the automatic volume control (AVC) circuit of a receiving system subject to strong signal reception, without preventing AVC action on the first tube during normal operating conditions.

The AVC circuit provides a uni-directional conductive device in the AVC line between the control grid of the first tube and the control grid of each of the following tubes, the device being conductive when the AVC line is more negative than the control grid of the first tube and being non-conductive



when the control grid is more negative than the AVC line.

The schematic diagram shows an aircraft receiver incorporating this arrangement by application of a vacuum tube diode.

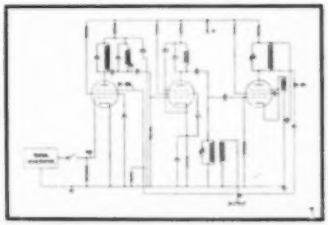
Patent No. 2,563,052 was issued on August 7, 1951 in the name of Olin L. Mac Sorley.

FREQUENCY DIVIDER

This invention presents a frequency division system of improved stability which is insensitive to amplitude changes in the incoming signal. Both input and output are sinusoidal and no output is produced in the absence of an input signal. Furthermore, the system is very stable over a band of frequencies.

Its basic principles involve beating an input signal of high frequency KN, where K is a whole number constant greater than unity, with a lower frequency signal $(K\text{-}1)\ N$ to obtain a still lower frequency signal N. Signals of approximately the frequency $(K\text{-}1)\ N$ exist in the system in small amplitude during the absence of the input signal, but immediately upon application of the input signal, a beat signal of approximately the desired frequency N is produced.

Patent No. 2,562,952 was issued August 7, 1951, in the names of Carl M.



Russell, Keith R. Symon and Robert C. Padesky.

AM Transmitter

(*Continued from page 5*)

panel may be placed on a bench or table for any service work that may be required.

The present day manufacturing problems, which involve high costs for fabricated parts and assemblies, together with the difficulties of procuring materials, have been held to a minimum. However, the BTA-5G/10G design has provided the many additional features that have been described, plus the removal of the unnecessary parts, and ofttime cumbersome items, that made it possible to accomplish this present improved design.

Video Probe

(*Continued from page 16*)

at the input of the attenuator. The top or front section of the probe is the attenuator; the bottom section is the cathode follower. The attenuator may be unplugged after two screws are loosened. Components for each section are mounted on a phenolic strip which rests on two shelves attached to the end pieces, with sufficient clearance for air cooling around the triode. The over-all dimensions of the assembled outer shell are 7 x 1⅛ inches.

A single leg, or "unipod", was devised to overcome the difficulty of using the probe to test a vertical panel. The leg is a ¼-inch bakelite rod, about 12 inches long. One end is mounted pivotally toward the back of the probe, permitting the free end to rest against the chassis of the subassembly for support.

Specifications

Attenuators

Attenuators include 1:1, 3:1, 10:1, 30:1, and 100:1 types. All have an input impedance representable by a resistance of 10 megohms shunted by a capacitance of 2 to 8 $\mu\mu$fd.

Cathode Follower

Input signal amplitude ± 1.8 volts maximum; ± 0.15 volt minimum. (Both determined by the amplifier used with the probe.) The circuit has a high-frequency response impedance level of 10 megohms within the usable range. Gain is approximately ½; output impedance, 93 ohms. The tube used is a subminiature triode, SC968.

Power Supply

If the probe is used near its video amplifier and synchroscope, power is obtained from a supply mounted on the synchroscope chassis. If it is used at a remote distance, the same power supply is available in a portable case. Voltages used are + 75 v. d.c. and 6.3 v. a.c.

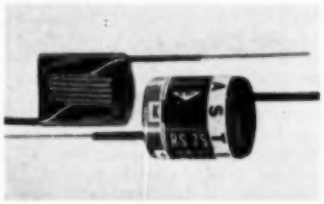
New Products

(*Continued from page 25*)

tiometer, (3) direct load connection with the control diode for regulations of voltages; four vacuum tubes and no relays; and tube filament voltages regulated for long life.

ELECTRONIC SELENIUM RECTIFIERS

An improved design of molded-in electronic selenium rectifiers has been announced by *Electronic Devices Inc.*,



Precision Rectifier Div., 429—12th St., Brooklyn, N. Y. Manufactured with bar or insulated tin-copper leads, the rectifiers have an outer case of spiral-wound phenolic wax which is rock hard at 100°C and whose thermal conductivity and low loss plates compensate adequately for the loss of cooling due to molding in.

In ratings from 250 ma. d.c. to 500 ma. d.c. the standard open plate construction is used. However, the high-efficiency plates lead to cooler operation and longer life.

CONTACT-OPERATING SWITCH

Developed for industrial use, the Type A-C-O Switch permits unusually fast switching by the return-action design of the operating plunger mechanism, which is insulated from the contacts. The *General Control Company*, Boston 34, Mass., announces that its typical applications are on machine tools, circuit transfer of timers and recording equipment; in safety circuits, and as a limit switch. The operation is such that the first press transfers the contacts, and the second press restores them, with single-pole, double-throw contacts permitting adaptation of the A-C-O switch to either normally closed or normally open circuits.

MULTIPLE PRECISION CONTROL

The Series 42A potentiometer, manufactured by the *Clarostat Manufacturing Company, Inc.*, Dover, N. H., accomplishes simultaneous control of 2 to 20 circuits or functions in electronic computing equipment.

Encased in a mineral-filled bakelite housing, designed to lock together with similar units forming a single tandem assembly that is held together by metal end-plates and threaded tie rods, the potentiometer has a resistance range of 100 to 100,000 ohms for linear windings. The contact arm of each unit can be readily adjusted on the common shaft that slips through the tandem sections, synchronizing with the common shaft or with the contact arms of other units.

News Briefs

(*Continued from page 23*)

putation. Having been granted a Ph.D in 1950, Dr. Hoffman was the recipient of a Pulitzer scholarship, a New York State scholarship and a Columbia University fellowship.

Appointed to the consulting staff of the National Bureau of Standards is Dr. Frank Wenner, consulting physicist in the development of electrical instruments for the *Rubicon Company*.

NEW LITERATURE

Wire Wound Potentiometers

The *DeJur-Amsco Corporation* has issued a new four-page catalogue covering its line of series L-400 precision wire-wound potentiometers.

The catalogue No. RE-L is available by writing to *DeJur-Amsco Corporation*, Industrial Division, 45-01 Northern Blvd., Long Island City, N. Y.

Balitron Circuits

(Continued from page 8)

of the tube was 17 per section, the total voltage gain was found to be 82. Oscilloscope patterns showed no noticeable distortion.

A circuit which is of doubtful value at the present time, but interesting, nevertheless, is the negative resistance amplifier circuit shown in Fig. 5. The *R-C* circuit, shown in Fig. 5A, looks like an ordinary *R-C* amplifier, but the factor of negative R_c on P_c-T_c changes the whole concept.

When the source (S) drives N_s negative, the current to T_c-P_s is increased. This increase in current lowers the T_c-P_s voltage, and the negative R_c condition tends to increase the current to this member above the change produced by N_s. The current to T_c-P_s will continue to increase until either the source changes the value of voltage applied to N_s in the opposite direction, or the lower limit of negative R_c is reached.

When the signal voltage from the source (S) approaches its maximum negative value, the negative R_p will continue to act on the beam until the signal voltage has changed sufficiently towards the positive to counteract the effect of this action. When this occurs, it causes a reversal of the negative resistance action and $I_{T_c P_s}$ is decreased, both by the signal voltage acting upon N_s and the negative R_c which is now trying to increase the voltage and decrease the current to that member. This action continues as the source goes through zero and climbs to the positive peak of the input signal. Here again, the N_s voltage must be changed sufficiently to overcome the negative R_p condition before another reversal of operation can take place.

Obviously, regeneration is taking place within the tube due to the negative resistance characteristic. This regeneration is not, however, that which is ordinarily conceived. This negative resistance regeneration differs from the normal regeneration in that no actual feedback of ordinary resistance, capacity, or inductive origin takes place. In addition, the actual value of the input signal is in no way altered as in ordinary regeneration.

The gain of this amplifier is extremely large and the ordinary values of gain are vastly exceeded. One model of this tube had a maximum theoretical gain of 17.4 but produced a total gain of 196.

To reduce the negative R_p regeneration and increase the fidelity without sacrificing the vast gain of this tube entirely, actual regenerative feedback can be utilized. This condition is shown in Fig. 5B where the capacitor C is coupled directly from T_p-P_s to N_s. In this circuit, when the T_p-P_s voltage tends to swing positive or negative, voltage is fed back to N_s out of phase with the signal voltage on N_s, and the swing upon T_p-P_s is reduced. Thus, a normal regenerative circuit (capacity between grid and plate) is used to provide degenerative feedback. If C is made variable, it could be used as a gain control. But the fact that capacity is deliberately inserted between the input and output elements of the tube is of tremendous importance, since it illustrates most fully the freedom from normal capacity coupling.

A problem that has been the subject of considerable study has been the development of a means of directly coupling the plate of the first amplifier of a series to the control element of the next amplifier. Many of the direct-coupled circuits are well known, such as the Loftin-White circuit and the various d.c. amplifier circuits. Most of these circuits require a tapped power supply.

The Balitron offers a new solution to this problem. Previously, the limiting factor on direct coupling has been the necessity of operating the control element of the following tube at, or near, the cathode potential of that tube. In the Balitron, changes in tube design have produced a tube which requires a positive bias of up to 90 volts to reach cross-over (the point where the currents flowing to T_c and T_p are equal.) Under these circumstances, coupling from a previous amplifier plate to the control element of a Balitron amplifier can be accomplished as shown in Fig. 7.

Here, V_1 is any type of low voltage amplifier, such as a 6SQ7, where the load resistance R is acting as the plate load and dropping the plate voltage to the operating value. Signal voltage is applied to the grid of V_1 and normal amplification takes place. The plate of V_1 is tied directly to N_s of the Balitron tube, V_2. Changes in the plate voltage of V_1 change the voltage on N_s, and the current through the Balitron is swung to produce an output in the transformer T_r.

It would be supposed that the positive N_s would draw large amounts of current from the cathode of V_1 and produce damping action upon the signal voltage. But such is not the case. Due to constructional design, N_s does not draw current until the N_s voltage rises to approximately 95 volts. For this reason, no power is drawn by the input, and the signal voltage is not damped.

The elimination of tube-introduced noise is one of the major problems of radio engineering. Hum, various phenomena introduced by the electron energy quantum, and variations produced by changes in value of applied potentials, all combine to produce output voltages which are not introduced by the input signal. In the Balitron, a new approach is offered to the problem. Since this tube operates normally as a single-ended input, push-pull output amplifier, it is quite obvious that it has all the hum suppressing characteristics of any push-pull circuit. Thus, power supply variations are not such a source of trouble.

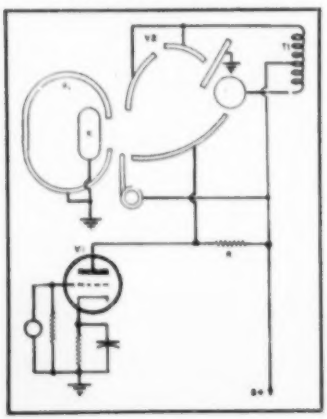
Changes in cathode emission of either a periodic or random nature, such as shot effect, are then introduced into a push-pull circuit. Since these effects produce changes in the number of electrons in the beam, and since the variation splits into two substantially equal parts flowing in opposite directions in the plate circuit, it is clear that the effective noise voltage produced in the secondary will be zero. Changes in the accelerating anode voltage produce the same effect as a change in electron emission, and the resultant noise voltage is again zero.

Thermal agitation in the input is not, of course, affected by these conditions. Partition noise is reduced because the receiving elements are on nearly the same concentric plane and not dispersed in a series of concentric attractive planes.

Part of the problem would then seem to be solved by the use of the Balitron. The fidelity of response should be exceptionally good. The use of the Balitron as an r.f. preamplifier should increase the available signal-to-noise ratio values.

An effort has been made here to show some of the more important circuits and applications of the Balitron that have been discovered which differ markedly from the ordinary tube. These are special applications of the Balitron and should not be thought to be limitative of its field of application.

Fig. 7. Direct-coupled amplifier circuit which overcomes many disadvantages of conventional circuits.



It must be emphasized that the full possibilities of these circuits have not been made by the author. The main interest of the author has been the development of the Balitron into an effective tube. However, the research problems presented various aspects of design which were recognized as sources for additional investigation. Insofar as possible, preliminary tests have been made on these circuits with positive results. Research facilities and time limitations have forced these tests to be modest. Qualitative analysis has not, therefore, been undertaken.

Without full investigation into all the aspects of these circuits, these can only be construed as suggestions with some supporting evidence to indicate their workability. Additional research must be undertaken to establish their true value.

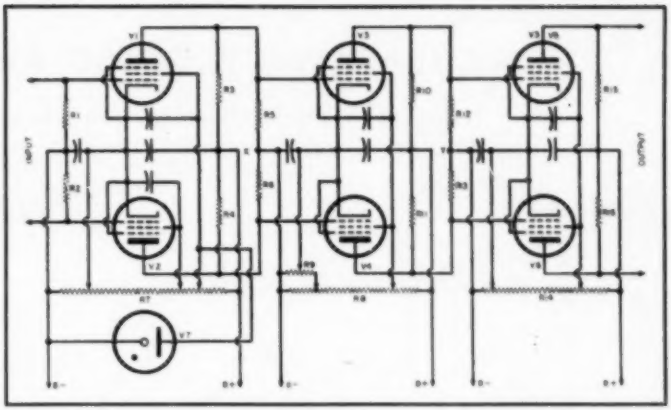


Fig. 5. Circuit diagram of a complete, three-stage amplifier using the principles outlined in this article. The amplifier is pictured on page 9.

Rectilinear Amp.

(*Continued from page* 10)

photoelectric cell which is measured in fractions of a microampere, and deliver over 150 mils at 300 volts in the output of each power tube, which is equivalent to approximately 45 watts of power.

Freq. cps	Input Volts	Output Volts
Zero	.0100	182
30	.0100	190
50	.0105	200
100	.0107½	215
250	.0100	220
500	.0100	200
1000	.0100	200
2500	.0102	204
4000	.0102	204
7500	.0102½	205
10,000	.0105	208
15,000	.0110	210
20,000	.0125	212
30,000	.0150	216

Table 1. Frequency response of the complete amplifier from zero to 30 kc. It can be seen that the average gain is about 20,000, and that this value is closely approached throughout the total range of 0 to 30 kc.

Table I indicates the frequency range of the amplifier, with its related input and output voltage differential. With a square wave signal pattern of up to 30 kc. applied to the input terminals, essentially an exact duplicate of this pattern is produced in the output circuit, as pictured on an oscilloscope, indicating that the time rise factor is very low.

The stability of this amplifier is such that it can not be made to oscillate under any normal operating conditions. A variation of over 25% can take place in the power supply with no appreciable change in the output circuit. The a.c. hum is less than one tenth of one percent of the output signal, although a relatively small amount of filtering is used in the a.c. power supply units.

The values of the resistors of the circuit will depend upon the characteristics of the tubes. The condensers used are merely for bypass purposes of the filtered power supply. Tubes V_1 and V_2 are in a bridge-type circuit arrangement with a potentiometer across part of the B power supply of the screen grid circuit. This layout provides for an automatic biasing control in the input of the next stage so that zero potential is applied to the grids of the following two tubes at zero signal. Thus, when a signal is impressed upon the input terminals, the circuit of one tube is 180 degrees out of phase with the other tube, with a resultant push-pull action.

The plates of V_1 and V_2 are directly connected to V_3 and V_4, respectively. However, the B supply of V_1 and V_2 is independent of the B supply of V_3 and V_4. The output plate circuit of the power stage is coupled through two resistors. Due to the potential difference across these two resistors, only the a.c. component is impressed upon the output circuit. The heater current for these various tubes is applied in the conventional manner.

Although this amplifier was developed primarily to be used in conjunction with the photoelectric engraver with all its exacting requirements, it is by no means limited to this use only. Its predominant use would be in the extreme low frequency field where it may take minutes, hours, or even days for a significant change to take place, and then this change may occur quite suddenly, in as much as a thousandth part of a second or less. Considering the circuit characteristics, it has a wide adaptation in practically the entire field of electronics.

PHOTO CREDITS

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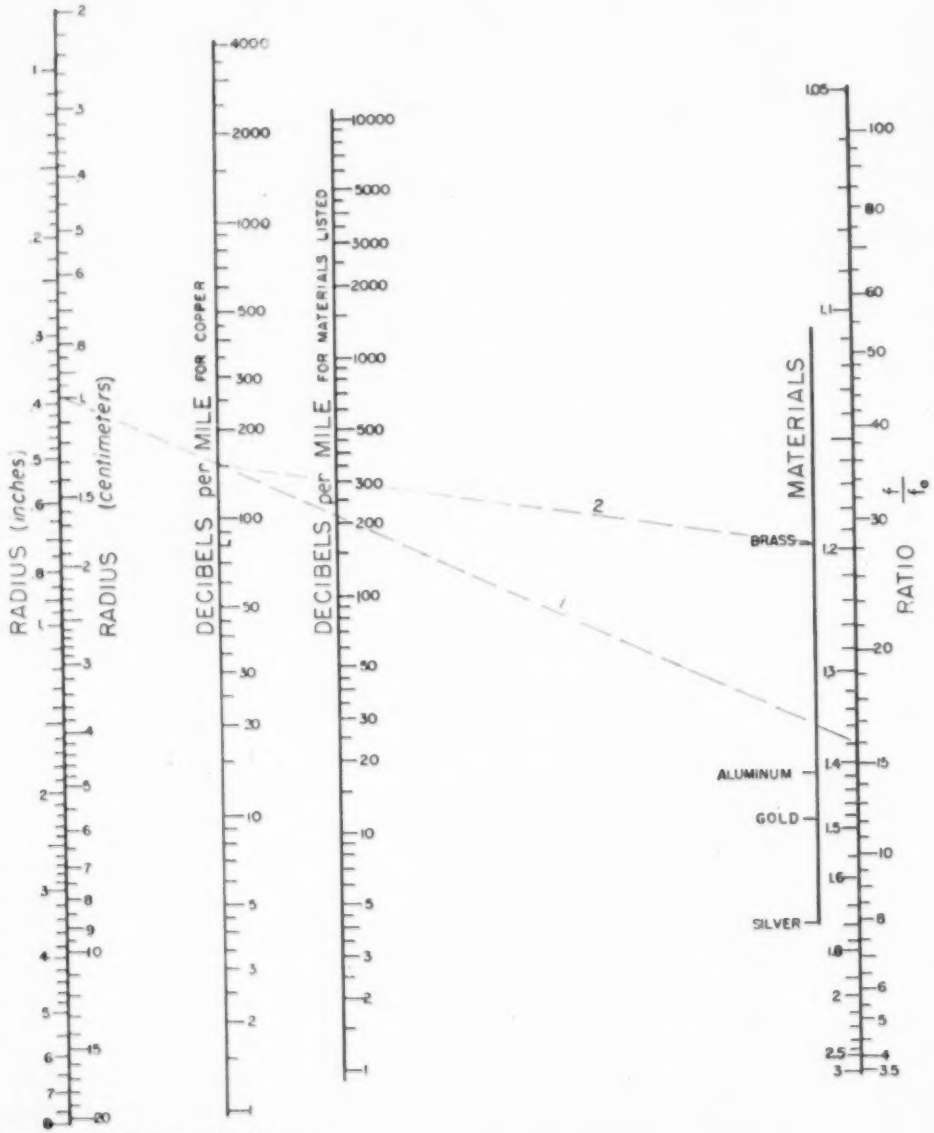
14, 15, 20	National Bureau of Standards
16	Massachusetts Institute of Technology

CIRCULAR WAVE GUIDE ATTENUATION

Nomograph for determining the attenuation of the $TE_{1,1}$ (H_{11}) mode in a circular air-dielectric wave guide.



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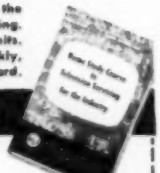

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You're an "expert, reliable service-man who does a tough job well," Bill Shipley, crack CBS-TV announcer, tells your prospects. And, he adds: "Always look for that Sylvania Service Emblem." That's how the hard-hitting, full-minute commercials on Sylvania's CBS-TV show, "Beat the Clock," put Bill Shipley, Roxanne, and Bud Collyer on your sales staff.

Roxanne and Bud Collyer are seen weekly over CBS-TV in 35 cities . . . selling your service . . . when you display the Sylvania Service Emblem.

Make this great national ad campaign pay off in your store

Mail the coupon below for FREE, full-color folder giving complete details about Sylvania's compelling Spring Service Dealer Advertising Program. It contains everything to identify you unmistakably as the dealer advertised in Sylvania's magazine and TV advertising. If you want more business, you can't afford to miss it. But, time's awastin' . . . get that coupon in the mail NOW!

SYLVANIA

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

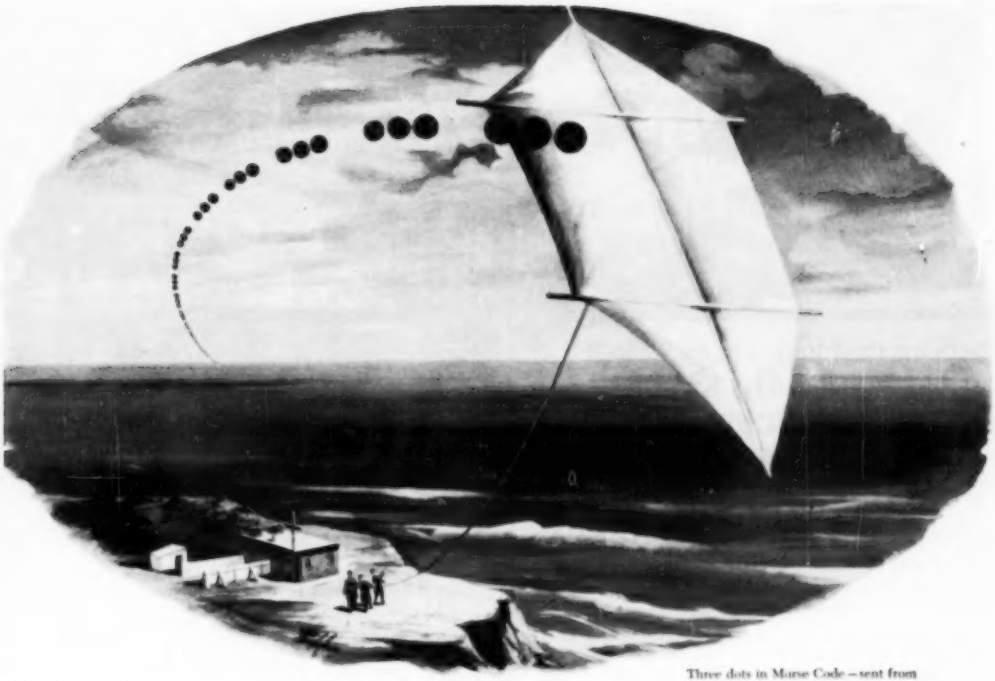
Sylvania Electric Products Inc.
Dept. R-2301, Emporium, Pa.

Please send me full details about Sylvania's powerful business-building campaign for Service Dealers.

Name _____

Strete _____

City _____ Zone _____ State _____



Three dots in Morse Code – sent from England and received by Marconi in Newfoundland – proved that wireless signals could span the Atlantic.

Three dots that opened a new era!

When Marconi, on December 12, 1901, heard a "3-dot" radio signal – the letter "S" in Morse Code – across 1,800 miles of sea, it was an experimental triumph that opened a new era in communications.

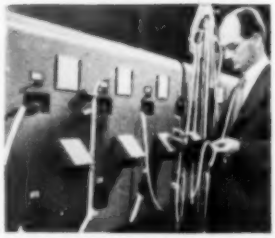
Before this historic event, wireless telegraphy had been limited primarily to communications between the shore and ships at sea. Marconi's success, however, was the forerunner of many other developments which led eventually to RCA world-wide radiotelegraph service that now operates more than 80 direct circuits to 66 countries.

As radio progressed, its usefulness was expanded by invention and development of the electron tube, the harnessing of short waves which made world-wide transmission a reality, and the automatic transmission and reception of messages at high speed.

Radio, with its magic of spoken words and music broadcast over the world . . . *television*, the miracle of pictures in motion transmitted through the air . . . these mediums of modern communication have added notable links in the chain of electronic advances first forged in 1901 from the mere sound of three dots.

* * *

See the latest wonders in radio, television, and electronics at RCA Exhibition Hall, 36 West 49th St., N. Y. Admission is free. Radio Corporation of America, RCA Building, Radio City, N. Y. 20, N. Y.



Today RCA Communications sends and receives about 81 million words each year across the Atlantic; the messages are automatically recorded on tape, for error-free transmission.

RCA **RADIO CORPORATION of AMERICA**

World Leader in Radio – First in Television

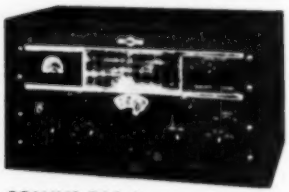
PRICES Slashed

SAVE UP TO 50% during GIGANTIC CLEARANCE SALE of USED TEST and COMMUNICATION EQUIPMENT

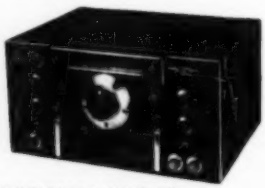
OUR $50,000 STOCK OF RECONDITIONED, "GOOD-AS-NEW" EQUIPMENT MUST GO AT A RECORD-BREAKING SACRIFICE TO MAKE ROOM FOR NEW MERCHANDISE!

Only the popularity of our "Surprise" Trade-In Allowance policy enables us to offer these wanted, late-model units at unheard-of low prices.

All equipment thoroughly checked and guaranteed to be in normal operating condition when shipped. While the following is only a partial list of our huge inventory (available at the time this publication goes to press) bargains like these simply can't last! So act now and avoid disappointment. Wire, write, phone or use the handy coupon today! When ordering, indicate first, second and third choice. All merchandise subject to prior sale.



COLLINS 75A-1



NATIONAL HRO-50

HICKOK 505
Test Instrument

FREE!

Complete list of used test and communication equipment bargains. Thoroughly checked and tested. Many of them are late model units. All are offered at sacrifice prices. Send for your free list today.

All Prices
F. O. B. St. Louis

Phone CHestnut 1125

USED COMMUNICATION EQUIPMENT

COLLINS 75A1 RECEIVER AND SPEAKER	$275.00
HALLICRAFTERS HT18 VFO	89.50
HALLICRAFTERS S38B RECEIVER	42.50
HALLICRAFTERS SX42 RECEIVER LESS SPEAKER	225.00
HALLICRAFTERS SX43 RECEIVER LESS SPEAKER	134.50
HALLICRAFTERS SX71 RECEIVER LESS SPEAKER	155.50
NATIONAL HRO5TA1 with Power Supply, less Speaker and 4 Coils	175.00
NATIONAL HRO-50 RECEIVER WITH SPEAKER AND 4 COILS	289.50
NATIONAL NC183 RECEIVER AND SPEAKER	209.50
RME HF10-20 CONVERTER	59.00
SONAR XE10 FM EXCITER	14.95

USED TEST EQUIPMENT

PRECISION EV10 VTVM	$ 49.50
RCA RIDER CHANALYST	89.50
HICKOK 305 3" OSCILLOSCOPE	89.50
HICKOK 505 5" OSCILLOSCOPE	139.50
RCA 155 3" OSCILLOSCOPE	47.50

Walter Ashe Radio Co. R-52-1
1125 Pine St., St. Louis 1, Missouri

☐ Rush my order for Used Equipment as follows:
(1st choice) .....
(2nd choice) .....
(3rd choice) .....

☐ Remittance for $ ..... is enclosed.
☐ Send FREE List of Additional Used Equipment Bargains.

Name .....
Address .....
City ..... Zone ..... State .....

Walter Ashe RADIO CO.
1125 PINE ST. • ST. LOUIS 1, MO.

NOW–Be a Fully Trained, Qualified RADIO TELEVISION TECHNICIAN IN JUST 10 MONTHS OR LESS!

I Send You 18 BIG KITS OF RADIO-TELEVISION EQUIPMENT

TRAIN AT HOME IN SPARE HOURS!

IF YOU ARE EXPERIENCED IN RADIO

Men already in Radio who seek a short intensive 100% TELEVISION Training with FULL EQUIPMENT INCLUDED are invited to check and mail the coupon at the right.

New "Package" Unit Training Plan

PAY AS YOU LEARN—YOU SET THE PACE!

No Monthly Payment Contract to Sign!

Now . . . be ready for Radio-Television's big pay opportunities in a few short MONTHS! Frank L. Sprayberry's completely new "Package" training unit plan prepares you in just 10 MONTHS . . . or even less! Equally important, there is NO monthly payment contract to sign . . . thus NO RISK to you! This is America's finest, most complete, practical training—gets you ready to handle any practical job in the booming Radio-Television industry. In just 10 months you may start your own profitable Radio-Television shop . . . or accept a good paying job in this fascinating expanding field at work you've always wanted to do. Mr. Sprayberry has trained hundreds of successful Radio-Television technicians—and stands ready to train you in less than one year, even if you have no previous experience. You learn by DOING . . . actually working with your hands with equipment of special design to illustrate basic theory instead of relying on books alone.

VALUABLE EQUIPMENT INCLUDED WITH TRAINING

The new Sprayberry "package" plan includes many big kits of genuine, professional Radio-Television equipment. While training you actually perform over 500 demonstrations, experiments and construction projects. In addition, you build a powerful 6-tube standard and short wave radio set, a multi-range test meter, a signal generator, signal tracer, many other projects. All equipment is *yours to keep* . . . you have practically everything you need to set up your own service shop. The interesting Sprayberry book-bound lessons and other training materials . . . all are yours to keep.

EARN EXTRA MONEY WHILE YOU LEARN!

All your 10 months of training is AT YOUR HOME in spare hours. Keep on with your present job and income while learning . . . and earn EXTRA CASH in addition. With each training "package" unit, you receive extra plans and ideas for spare time Radio-Television jobs. Many students pay for their entire training this way. You get priceless practical experience and earn generous service fees from grateful customers. Just one more reason why the Sprayberry new 10 MONTH-OR-LESS training plan is the best Radio-Television training in America today. If you expect to be in the armed forces later, there is no better preparation than good Radio-Television training.

FREE 3 BIG RADIO TELEVISION BOOKS

I want you to have ALL the facts about my new 10-MONTH Radio-Television Training—without cost! Act now! Rush the coupon for my three big Radio-Television books: "How to Make Money in Radio-Television," PLUS my new illustrated Television Bulletin PLUS an actual sample Sprayberry Lesson—all FREE with my compliments. No obligation and no salesman will call on you. Send the coupon in an envelope or paste on back of post card. I will rush all three books at once!

SPRAYBERRY ACADEMY OF RADIO
Dept. 75-E, 111 North Canal St., Chicago 6, Ill.

Mail Coupon Today!

NO OBLIGATION
No Salesman Will Call

SPRAYBERRY ACADEMY OF RADIO, Dept. 75-E
111 North Canal St., Chicago 6, Ill.

Please rush to me all information on your 10-MONTH Radio-Television Training Plan. I understand this does not obligate me and that no salesman will call upon me.

Name.....Age.....

Address.....

City.....Zone.....State.....

Please check Below About Your Experience

☐ Are You Experienced? ☐ No Experience

Within the INDUSTRY

ROBERT T. PENNOYER, manager of the *General Electric Company's* Buffalo Tube Works, has been appointed manager of the newly-established tube department advanced manufacturing section in Schenectady.

He will be succeeded at Buffalo by Harry R. Hemmings of Syracuse who has been purchasing supervisor for cathode-ray tubes at the *G-E* Electronics Park plant.

The new advanced manufacturing section will be devoted to the improvement and development of tube manufacturing processes.

Mr. Pennoyer, who holds a B.S. in electrical engineering and a master's degree, joined *G-E* in 1933.

• • •

W. F. E. LONG of Washington, D. C., has been named director of statistics for the Radio-Television Manufacturers Association.

Mr. Long who took office in November of last year is in complete charge of all of the Association's statistical activities, most of which have been handled previously by *Haskins & Sells* of Philadelphia.

He resigned as director of the statistical division of the National Paint, Varnish and Lacquer Association to take this new post.

• • •

DR. LAN JEN CHU, internationally-known physicist, has been named director of research for *The Gabriel Company* of Cleveland. Two divisions of the parent firm are active in the radio and television field, *The Ward Products Division* and *The Workshop Associates Division.*

Dr. Chu is a graduate of Chiao Tung University in Shanghai where he received his B.S. degree in Electrical Power in 1934, and his M.S. degree in 1935. In 1938 he received his doctorate in electrical engineering at M.I.T. Before joining the staff of the Radiation Laboratory of M.I.T. in 1942, Dr. Chu was consultant on electromagnetic problems to the Radiation Laboratory and Radio Research Laboratory.

• • •

GENERAL ELECTRIC COMPANY'S Electronics Division has announced plans to use two buildings and part of a third at Bridgeport, Conn. for the design and manufacture of military electronics equipment. Approximately 150,000 square feet of floor area will be turned over to the new operation . . . **PAUL ROSENBERG ASSOCIATES,** consulting physicist firm, has moved to new and larger quarters at 100 Stevens Avenue in Mount Vernon, New York . . . **ELECTRONIC ENGINEERING COMPANY OF CALIFORNIA** is now occupying its new two-story building at 176 S. Alvarado Street, Los Angeles. The new quarters provide enlarged engineering offices and laboratory facilities . . . **ASTRON CORPORATION,** manufacturers of condensers and r.f. interference filters, has acquired additional space at 255 Grant Avenue in East Newark, N. J. to handle the increased demand for its products.

• • •

GEORGE W. HENYAN, manager of *General Electric Company's* industrial and transmitting tube operations for the past three years, has accepted a temporary appointment as chief of the components branch of the National Production Authority's electronics division.

A veteran of 33 years with *G-E*, he will make his headquarters in Washington, D. C. He joined the company in 1916 after receiving his degree in electrical engineering from the University of Texas and has been with the company continuously except from 1917 to 1919 when he served with the armed forces.

• • •

WESTINGHOUSE AIR BRAKE COMPANY has acquired all of the capital stock of **MELPAR, INC.** of Alexandria, Va. and Cambridge, Mass. The new subsidiary will continue in the field of research and development on radio and electronic equipment. . . Alfred W. Russell has announced the formation of **RUSSELL REINFORCED PLASTICS CORPORATION** to manufacture low pressure laminates and flat board stock of Fiberglas-polyester construction. The company's main office is at Hicksville, N. Y. . . . **MAGNO RECORDING STUDIOS** is the corporate name of a new firm established to provide facilities for personal transcriptions and commercial recordings on tape and discs. Studios have been set up at 37 W. 57th Street in New York City. A. J. Dash heads the new organization . . . The formation of **AUDICRAFT INC.** has been announced by Alan Abrahams, president. The Brooklyn firm, located at 77 South 5th Street, is manufacturing horn loudspeakers

PRESENTING COLLINS AM-FM "PRE-FAB" TUNERS

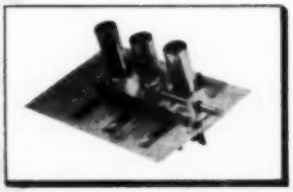
***NOW** you can build a Collins AM-FM tuner from the Pre-Fab units shown below!*

COMPLETE VERSATILITY is the byword in this new tuner design. Through the addition of the AM circuit, the Collins tuner will meet all requirements for home music systems and installations where a fine tuner is required.

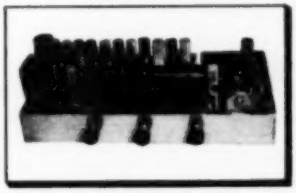
ECONOMY: The very finest in tuner design is offered you at exceptionally low prices. Collins quality is your assurance of a fine product that will work to your complete satisfaction. You cannot duplicate this tuner in its completed form at *twice the price!*

3 Ways to purchase COLLINS Tuner . . .

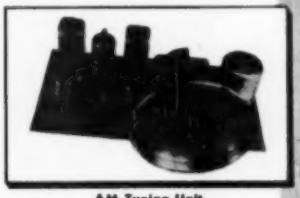
1. **As an AM tuner kit**
2. **As an FM tuner kit**
3. **As an AM-FM tuner kit**



FM Tuning Unit **$15.25**



The Collins FM-AM Pre-Fab Tuner Assembled (Total Kit Cost **$69.00**)



AM Tuning Unit (Includes IF and Audio Amplifier) **$19.25**

FM IF Amplifier **$19.75**

Tuning Eye Kit Available At **$2.85**

UC-2 Universal Chassis Kit **$14.75**

The FM tuning unit employs 6J6 RF amp., 6AG5 converter, and 6C4 oscillator. Permeability tuned, stable, and drift-free. The IF amplifier for FM uses 6BA6, (4) 6AU6, and 6AL5 discriminator high gain, wide band for high fidelity reception. Distortion less than ½%. Frequency response 20 to 20,000 cycles at detector output.

The AM tuning unit employs three tubes, one of which performs the function of both detector and first audio amplifier stage. AM IF amplifier also is included in the tuning unit. Tubes used: 6BE6, 6BA6, and 6AT6.

Tuner kit is supplied with AM/FM selector switch, volume control and AC switch, and tuning knob. Complete instruction manual with schematics and pictures included.

MAIL ORDER COUPON TODAY!

TO: COLLINS AUDIO PRODUCTS CO. INC.
P.O. Box 368, Westfield, N.J.

Enclosed Find ☐ **Check** ☐ **Money Order For**

- ☐ **AM Tuning Unit**
- ☐ **FM Tuning Unit**
- ☐ **FM IF Amplifier**
- ☐ **UC-2 Chassis Kit**
- ☐ **M-1 Tuning Eye Kit**

NAME_____

ADDRESS_____

CITY_____ STATE_____

. . . The **CROSLEY DIVISION** has purchased the physical assets of **BRAND AND MILLEN, LIMITED,** a radio and television manufacturing firm of Long Branch, Ontario. The Canadian firm will be operated as a wholly-owned subsidiary.

• • •

H. LAWRENCE KUNZ has been named general manager of the Capacitor Division of *Sangamo Electric Company.*

He has been with the company 25 years, having joined the organization after receiving his degree in electrical engineering from the University of Illinois.

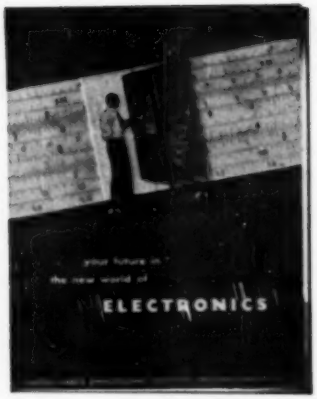
He has served as sales manager of the division he now heads for the past six years and prior to that was assistant general sales manager.

Mr. Kunz will make his headquarters at the division plant in Marion, Illinois.

• • •

FREDERIC J. ROBINSON has been named director of the international sales division of *Sylvania Electric Products Inc.* He has been the company's sales manager for Latin America since 1943 . . . **KEETON ARNETT** has joined the *Allen B. Du Mont Laboratories, Inc.* as general assistant to the president . . . The new sales manager for *Transmitter Equipment Manufacturing Company, Inc.* is **WALTER B. BROWN,** a former colonel in the Signal Corps . . . *Triad Transformer Manufacturing Co.* of Los Angeles has named **ERNEST CLOVER** to the post of director of jobber sales . . . **W. D. RENNER** is the new manager of sales engineering for *Howard W. Sams & Co.* He has been with the firm since its inception . . . *Pickering & Company* of Oceanside, Long Island has announced the appointment of **GEORGE P. PETETIN, JR.** to the post of assistant sales manager . . . **JOHN B. PATTERSON** is the new national advertising manager for *Federated Purchaser, Inc.* of New York. He was formerly with *Telrex, Inc.* . . . **FRANK B. ROGERS, JR.** has joined *Reeves Soundcraft Corp.* as vice-president in charge of sales . . . *Westinghouse Electric Corporation* has named **JAMES L. BROWN** sales manager for receiving tubes and cathode-ray tubes. He has been with the company for 14 years . . . **CHARLES ROBERTS** is the newly appointed advertising and sales promotion manager of *Fada Radio & Electric Co., Inc.* . . . The newly-created post of manager of the radio sales section for the *Crosley Division* is being filled by **HERBERT F. KOETHER** . . . **WILLIAM CARLIN** is the new manufacturing manager of the Cathode-Ray Tube Division of *Allen B. Du Mont Laboratories, Inc.* . . . **PAUL ECKSTEIN,** sales manager of *Hallicrafters,* has resigned to establish his own electronic manufacturers' sales represen-

(*Continued on page* 109)



How far ahead can you be next year . . .

IN TV AND ELECTRONICS?

◀ Send for this free CREI booklet today . . . and find out!

THIS BOOKLET can mean the difference between small, w-i-d-e-l-y s-p-a-c-e-d salary increases—and rapid advancement. Between routine work—and challenging opportunity. Between constantly defending your job against better-trained men — and dynamic confidence. Between short-circuited hopes—and high-powered ambition.

An exciting new world has opened up with such superspeed that even the most optimistic electronic experts fall short in their predictions of expansion.

Think of the 1,500 TV stations within the next 5 years and the 2,500 stations within 10 years, as predicted by the Chairman of the FCC. Think of the 13,000,000 TV sets now in use. *Remember that we weren't supposed to reach that figure until 1954.* Think of the 100,000,000 radios in current operation. (95% of the nation's homes have one or more sets.) Think of the tremendous defense orders now being placed for electronic equipment and installations.

Think of the thousands of radio-equipped fire and police departments throughout the U.S. Of the many radio-equipped railroads, of the hundreds of cities with 2-way radio service for cars and cabs. Think of the wide-ranging field of aviation communications—radio-controlled aircraft, navigation-and-traffic control, airport stations.

Think of the maritime world with its navigational aids, fathometers, ship-to-shore and ship-to-ship communications and radar. Think of electronic heating, fax and ultra-fax, of electronic medicine, and all the other applications of electronic know-how.

Countless positions must be filled—in development, research, design, production, testing and inspection, manufacture, broadcasting, telecasting and servicing. Who will get those positions? You—if you prepare today—if you are alert and have the ambition to advance your knowledge. You—if you take 2 minutes to send for a free copy of "Your Future in the New World of Electronics."

This helpful book shows you how CREI Home Study leads the way to greater earnings through the inviting opportunities described above.

However, being an accredited technical school, CREI does not promise you a "bed-of-roses." You have to translate your willingness to learn into saleable technical knowledge—via *study*. Since its founding in 1927, CREI has provided thousands of professional radiomen with technical educations. During World War II, CREI trained thousands for the Armed Services. Leading firms choose CREI courses for group training in electronics at company expense, among them United Air Lines, Canadian Broadcasting Corporation, Trans Canada Airlines, Sears Roebuck & Co., Bendix Products Division, All-American Cables and Radio, Inc., and RCA-Victor Division.

CREI courses are prepared by recognized experts, in a practical, easily-understood manner. You get the benefit of time-tested materials, under the personal supervision of a CREI Staff Instructor. This complete training is the reason why CREI graduates find their diplomas keys-to-success in Radio, TV and Electronics. CREI alumni hold top positions in America's leading firms.

At your service is the CREI Placement Bureau, which finds positions for students and graduates. Although CREI does not guarantee jobs, requests for personnel currently exceed supply by far.

Talk to men in the field and check up on CREI's high standing in electronics instruction. Determine for yourself right now that your earnings are going to rise with your knowledge—and that you get your rightful place in the Age of Electronics. All this CREI can promise you, provided you sincerely want to learn. Fill out the coupon and mail it today. We'll promptly send you your free copy of "Your Future in the New World of Electronics." The rest—the future—is up to you.

MAIL COUPON FOR FREE BOOKLET

CAPITOL RADIO ENGINEERING INSTITUTE
Dept. 111D, 16th & Park Rd., N.W., Washington 10, D. C.

Send booklet "Your Future in the New World of Electronics" and course outline.

CHECK FIELD OF GREATEST INTEREST
- ☐ TV, FM & Advanced AM Servicing
- ☐ Practical Television Engineering
- ☐ Broadcast Radio Engineering (AM, FM, TV)
- ☐ Practical Radio Engineering
- ☐ Aeronautical Radio Engineering

Name .....
Street .....
City ..... Zone ..... State .....
If residence school in Wash., D. C., preferred, check here ☐

Radio On The MAIN LINE

By
LEO G. SANDS
General Sales Manager
Bogue Electric Mfg. Co.

Control base station at B & O Ore Dock, Baltimore.

Licenses to operate two-way radio systems have been issued to 96 railroads in the U.S. Approximately 8½ million dollars have been invested in such equipment.

LICENSES have been issued covering the use of radio communications equipment on 5253 railroad locomotives, cabooses, and other rolling stock, at 365 yard or terminal base stations and wayside stations as of July 5, 1951 according to the Federal Communications Commission. This represents an investment of approximately $8 500,000 in equipment and appurtenances.

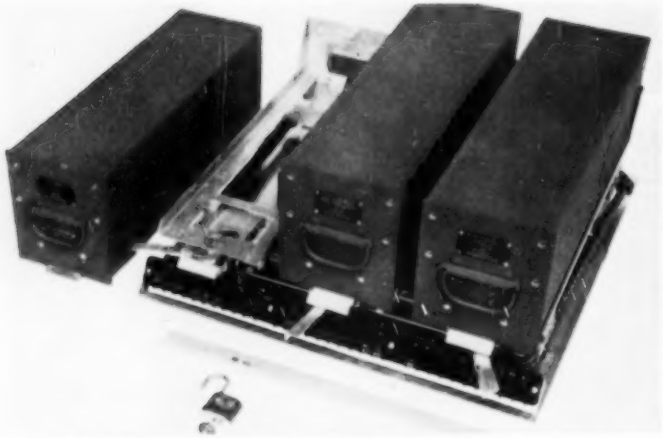
Of the nation's 131 class 1 roads, 52 are using two-way radio. The other 44 railroads using radio are terminal companies or short lines not listed in the category of class 1 railroads. The total number of railroad companies of all classifications in the United States is 1070. There are 476 line haul operating railroad companies and 213 operating switching and terminal railroad companies in the United States exclusive of the 131 class 1 roads.

The first permanent authorization to be granted to a railroad on a regular basis in the railroad radio service was to the *Denver & Rio Grande Western* on February 27, 1946. The *Baltimore & Ohio* received authority on August 15, 1946 to operate on a regular basis its radio communications system which had been authorized on an experimental basis on August 20, 1945 for operation at its yards near New Castle, Pennsylvania. Several other grants on a regular basis were issued soon after, some covering installations already in service on an experimental basis. The *Rock Island Line* was the first railroad to receive an experimental authorization to test two-way radio in rail operations on the 152 to 162 megacycle band. This permit was applied for on April 20, 1944 and was granted on February 26, 1945. At this stage of the railroad art, it had not yet been settled in the minds of all concerned that the 152 to 162 megacycle band was the most desirable part of the radio spectrum for railroad radio. The *Rock Island Line* conducted tests on frequencies as high as 2600 megacycles. Many tests using the 152-162 megacycle band were made by several railroads in conjunction with equipment manufacturers who were interested in getting into this new field.

The engineers of the *Bendix Radio Division* of *Bendix Aviation Corporation* with an extensive background of wartime v.h.f. experience were among the advocates of the 152-162 megacycle band. Using the famous SCR-522 which *Bendix* engineers designed for American military production, tests were conducted on several railroads in all parts of the country and under a multitude of conditions to prove that v.h.f. radio was a practical means of providing communications with moving trains and switch engines.

The SCR-522, an amplitude modulated airborne radio transmitter and receiver unit, was designed to operate on frequencies between 100 and 156 megacycles. It was possible to coax it to operate on 156.525 megacycles without modification. This frequency was made available by the FCC for railroad radio tests. Although designed to withstand the vibration and shock encountered in fighter planes, the SCR-522 would not stand up under the very different kind of shock and vibration to which it was subjected in railroad service.

The SCR-522, however, should be given credit for speeding the advent of the widespread use of radio by the railroads because it provided an immediate source of equipment operable at the desired frequencies. Based on the original SCR-522 design, present day railroad radio equipment has come through several stages. The equipment of today is less expensive and more compact than the early railroad radio equipment of 1945 and 1946. This early equipment is by no means obsolete today. Almost every piece of railroad



Bendix Type MRT-6 railroad radio unit. Transmitter, receiver, and power supply are shock mounted and may be locked in place to prevent unauthorized operation.

Up-to-date list of American railroads that are authorized to use two-way radio.

Alabama Great Southern
Alton & Southern
Apache
Atchison, Topeka & Santa Fe
Atlantic Coast Line
Baltimore & Ohio
Baltimore & Ohio, Chicago Terminal
Bangor & Aroostock
Barre & Chelsea
Bessemer & Lake Erie
Birmingham Southern
Boston & Maine
Brooklyn Eastern Dist. Terminal
Carbon County
Central of Georgia
Central Railroad of New Jersey
Central Railroad of Pennsylvania
Chattahoochee Valley
Chesapeake & Ohio
Chesapeake Western
Chicago & Eastern Illinois
Chicago & North Western
Chicago, Burlington & Quincy
Chicago Great Western
Chicago, Milwaukee, St. Paul & Pacific
Chicago, Rock Island & Pacific
Chicago, South Shore & South Bend
Columbus & Greenville
Colorado & Southern
Delaware, Lackawanna & Western
Denver & Rio Grande Western
Des Moines & Central Iowa
Detroit, Toledo & Ironton
Duluth, Mesabi & Iron Range
Elgin, Joliet & Eastern
Erie
Fort Worth & Denver City
Florida East Coast
Georgia Northern
Grand Trunk Western
Great Northern
Green Bay & Western
Gulf, Mobile & Ohio
Illinois Central
Jacksonville Terminal Co.
Kansas Oklahoma & Gulf
Lake Terminal
Lehigh Valley
Los Angeles Junction
Louisville & Nashville
Louisiana & North West
Maryland & Pennsylvania
McKeesport Connecting
Minnesota, Dakota & Western
Missouri - Kansas - Texas of Texas
Missouri Pacific
Modesto & Empire Traction
Monessen Southwestern
Monongahela Connecting
New Orleans Terminal Co.
New York Central
New York, Chicago & St. Louis
New York, New Haven & Hartford
Niagara Junction
North Louisiana & Gulf
Northern Pacific
Pacific Electric
Pennsylvania
Pittsburgh & Ohio Valley
Richmond, Fredericksburg & Potomac
River Terminal
St. Louis-San Francisco
St. Louis-San Francisco & Texas
Seaboard Air Line
South Buffalo
Southern Pacific
Southern
Steelton & Highspire
Texas & Pacific
Texas & New Orleans
Texas & Northern
Texas City Terminal
Toledo Terminal
Union Pacific
Union (Pittsburgh)
Walla Walla Valley
Washington & Old Dominion
Western Maryland
Western Pacific
West Virginia Northern
Point Comfort & Northern Railway

radio equipment that has been sold is in regular use today.

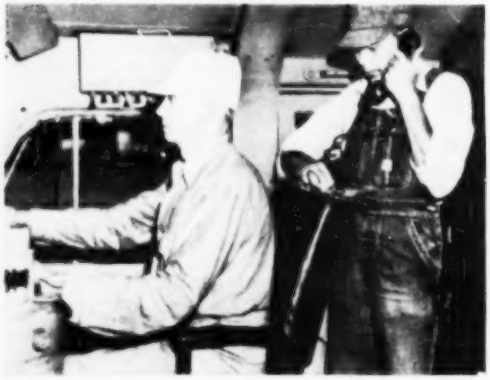
Going back to the very beginning, radio was used to communicate with moving trains in 1914 by the *Delaware, Lackawanna & Western Railroad*. Many tests on frequencies high and low had been conducted through the years, but it was not until 1945 that radio was given serious consideration by the railroads. Before 1945, the lack of suitable equipment and the state of the art prevented concrete action.

Now that radio communication has proved itself to be a valuable working tool, the rate at which railroads are installing radio is at an all-time high. The mere fact that equipment and frequencies were available was not enough to create immediate wide scale adoption of radio by the railroads. Many problems had to be overcome which involved operating rules and procedures, cooperation by labor, maintenance, primary electrical power, conversion from steam to diesel motive power, availability of versatile skilled maintainers, and the skepticism of a great number of men who had done the same thing the same way for the last fifty years.

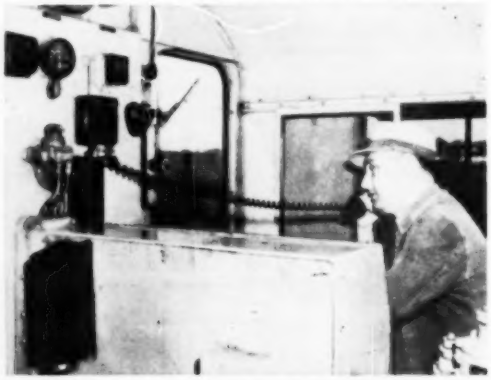
The men who maintain railroad radio equipment fall into many categories depending on the size and vitality of the railroad. On some roads, the radio technician must be an expert on telephone carrier equipment, teleprinters, and other communication devices associated with wire lines. On the *Santa Fe*, radio is handled by a highly skilled group specializing in electronics.

Maintaining radio equipment on a major railroad is not as easy as taking care of equipment for a police department or taxicab operator where all mobile units return to a base every day. On a railroad 2000 miles long, a locomotive with a radio unit requiring attention can be 2000 miles from the maintenance shop. This problem is being met by storing serviceable radio units at major points along the way so they may be interchanged enroute. Some roads maintain one service center, others several, shipping defective

A main line fireman talks to crew in caboose a mile behind.



Engineer on a diesel switch engine keeps in touch by radio.



units to service centers for repair. A planned preventive maintenance program helps reduce the number of equipment failures and cuts down the need for field service calls.

No accurate figures were found available on the number of persons engaged in maintaining railroad radio. It is hard to estimate the number because so few handle radio maintenance exclusively.

The Communications Section of the Association of American Railroads plays a major role in coordinating the assignment of frequencies and in the preparation of equipment performance standards. Representatives of the railroads who make up committee #4 of the A. A. R. Communications Section, prepare specifications to be used by manufacturers as a guide in designing equipment for railroad service and by the railroads to assist them in planning their radio facilities.

At first, the railroads installed radio at yard offices and on switching locomotives to expedite the movement of freight through yards and terminals. The savings effected by the use of radio could be more readily measured in this type of operation.

On the main line, the advantages of radio communication from engine to caboose seemed obvious, because the conductor and engineer, who are often separated by a train a mile long, normally cannot communicate with each other. With radio, the conductor can advise the engineer when to "high ball" after clearing a section of slow track and he can order the engineer to apply the brakes from the front end when necessary. Before radio, the brakes were often applied from the rear end when an emergency arose with the result that the train was often torn in two.

The economic advantages of radio for end-to-end communication have been measured and are attractive. However, the electric power source on the caboose was a source of major expense, much more than the cost of the radio equipment.

The normal approach would be the installation of a standard 32-volt train battery and an axle driven generator. Some railroads have installed butane or diesel engine driven generators to provide power. However, more machinery meant additional maintenance cost.

A more practical and less expensive solution was the installation of a 12-volt truck battery on the caboose which is kept charged by an axle or wheel driven generator or alternator-rectifier. This particular method has been adopted by many of the railroads with considerable success.

Heretofore, moving trains were out of touch with the outside world except for the limited one-way transmission of intelligence through the signal system. At certain points, written messages could be exchanged by train crews and wayside operators.

Several railroads are equipping waystations and trains with radio which will permit instantaneous contact with train crews. The *Chicago, South Shore & South Bend Railroad* was one of the first to equip its entire line with point-to-train radio communications facilities. The *Erie* has installed radio from Chicago to Jersey City, the *Baltimore & Ohio* from Fairmont, West Virginia to Connellsville, Pennsylvania and the short line *Washington & Old Dominion* along its entire right-of-way. The *Northern Pacific* is installing a main line train radio system extending across North Dakota to Montana which will permit waystation operators as well as the dispatcher, when necessary, to talk directly with train crews. The *Milwaukee Road* is installing point-to-train radio in South Dakota. News like this is getting common in the railroad trade journals. Radio has found its place on the main line.

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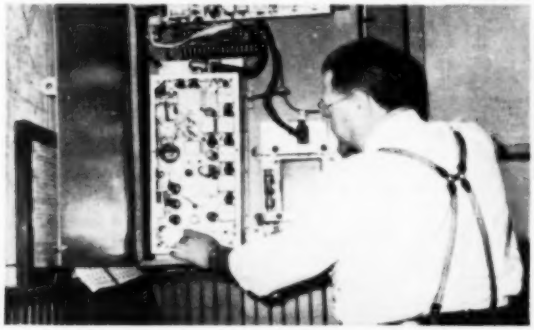
A radio-equipped locomotive operated by the Maryland & Pennsylvania R. R.

A yardmaster directs train crews by means of radio, thus keeping trains and freight moving without delays.



Lee Kemberlin checks the base station equipment at the Toledo Terminal Railroad office. Similar installations throughout the country help speed important freight shipments.

SUCCESSFUL SERVICING OF AUTOMOBILE RECEIVERS

Drive-in facilities are important feature of auto radio shop.

There is money to be made in car radio work—all it takes is the know-how and a few special tools.

By
I. J. SALTZMAN
Globe Radio & Sound Service

MOST radio technicians shy away from auto radio service because of their reluctance to get their hands dirty. Auto radio servicing is not white collar work but it is profitable. It has many advantages over television servicing and/or home radio servicing. Briefly, the greatest advantage to the auto radio technician is that the customer must drive his car to the radio shop, so the radio technician can use his time for radio servicing and not spend half of it traveling around from one service call to another. The technician can spend almost all of his time at his shop, do more repairs at lower rates, and end up making more money. Even when a job doesn't turn out 100%, the technician is protected to a great extent. True, the job must be done over again on a no-charge basis, but at least he does not have to travel out to the customer's house. Also, the customer is less apt to complain about imaginary troubles for he must use some of his free time to bring his car to the shop. As a result, you can safely say most auto radio complaints are true complaints, unlike television servicing where the customer only has to lift his telephone to call the TV technician to spend an hour of his time for some pseudo-reason. Unlike service shops handling home radio work, a successful auto radio shop must maintain a large parts inventory, a comprehensive accessory inventory, and must give faster service.

Many of the service troubles found in auto radios, such as the replacement of tubes or a vibrator, are quick repair jobs. Where this can be accomplished in the car, without removing the radio, a flat charge of two dollars plus parts is made. However, where the radio must be removed from the car and taken into the shop for repairs, an additional charge is made to cover the cost of removing the radio from the car, checking the radio on the bench, and re-installing it in the car. The charge will depend on how difficult a radio it is to remove and re-install. After the radio is checked on the service bench, the customer is informed as to the nature of the repairs that have to be made, and the total cost of the job. If he agrees, all is well and good. If he decides not to have the job done, the radio is re-installed in the car and he pays only the price agreed upon to cover the cost of removing, testing, and re-installing his radio. It is only on rare occasions that he does not have the repairs done.

Quick Service Expected

To be a successful auto radio technician, you must very frequently complete the job while the customer waits around. (While the customer is waiting around, somebody in our organization takes this opportunity to show him what we have for sale besides our services.) It is important to have a technician available when a customer calls at the shop. "The man is out to lunch" or "The man is out on a job and will be right back" does not satisfy the customer.

There are many customers who come around during their lunch hours or while driving past the shop and do not have much time to spend. This does not present any problem. To satisfy these customers, it is only necessary to remove the cover from the radio and replace a tube or vibrator or remove the radio from the car and take it into the shop for repair. The customer can usually drive away in less than fifteen minutes and call the shop later in the day for an estimate of the necessary repairs to his radio if it was necessary to remove it from the car. In a similar manner, he need spend only a short time at the shop while his radio is being re-installed.

We never charge for replacing a burned out fuse, for you know full well that there must have been a good reason for the fuse burning out and it is apt to happen again until the source of the overload is found and corrected. We explain this to the customer and inform him that if the fuse blows again, it will be necessary to check the radio. Once we replace the fuse at no charge, the next job on the radio is ours, and we can then trace down the overload at the customer's expense.

For auto radio work, you must have the correct physical size of parts as well as the correct electrical specs. Physical size is very important since auto radios are built quite compactly. Probably one of the greatest headaches is volume controls, which vary in size and shape with almost every car radio. Stocking the exact replacement parts is an expensive item. While having the exact parts on hand makes it possible to do a better job in less time, it must also be remembered that such parts, because of their very nature, cannot be used in but one or two models and so create quite an inventory problem. It becomes necessary to stock one or two pieces each of a great number of special parts. Parts for each manu-

facturer's radios must be ordered from another distributor as no one distributor can represent all the different automobile and radio manufacturers. Many of these parts will lay in the parts bins and never be used, but this is one of the hidden expenditures in auto radio servicing. However, it is because of this stock of special parts that people come to the shop to have their auto radios repaired.

Years ago, different manufacturers used different vibrators. Today, one or two types of vibrators will satisfy 90% of your needs. Volume controls and speakers are another matter. Each manufacturer has a different size bushing or shaft and most of them are dual controls. There is only one solution—stock the original part, bought directly from the manufacturer—universal controls are only a slight help.

We must stock antennas of various shapes and sizes to fit every car on the road. We do not stock cheap antennas for once one is installed on the customer's car, it is always before his eyes and as soon as it shows signs of rust or poor service, he automatically thinks of us. We do not try to compete with some of the chain auto accessory stores on cheap auto antennas. We sell something they can't sell—good service and better parts.

Regard the customer's car as you would his living room. Don't sit in his car with a screwdriver in your hip pocket for it is very likely to puncture the upholstery on the seat. Cover the seat with a seat cover or blanket. When working on the motor side of the firewall, cover the fender with a blanket. A perfect radio repair job cannot assure your customer satisfaction if you scratch his fender or in some other way do some slight damage to his car. Carbon tetrachloride is a most valuable chemical around any service shop, but it is even more valuable for removing spots from the customer's upholstery which somehow or other just were not there before the technician repaired the radio. We have a cardinal rule that the service technician must not smoke in the customer's car. Upholstery and slip covers burn easily.

Promoting Auto Service

Sources of business are varied. The car manufacturers will enter into agreements with service stations to repair, during the warranty period, auto radios sold through car dealers. They have a flat rate—$2.00 for minor repairs and $3.50 for major repairs. It is only necessary to write the manufacturer and list your qualifications and, after an inspection, you can be listed as an authorized service station. Used car dealers have to recondition and repair radios in cars before they sell the cars. New car dealers repair "out of warranty" radios for their customers as an accommodation. Some manufacturers expect the car dealer to maintain his own radios. Used car dealers are expected to deliver a car with a working radio. After the customer has taken delivery, the car dealer sends the customer with a purchase order to our store—we repair the radio and bill the dealer.

The average family car is your biggest source of business—but special sources, such as police cars, ambulances, trucks, and reporters' cars will be tapped too by a wide-awake organization.

It is advisable to have drive-in facilities for the installation and repair of radios. There is a great deal of business done during rainy and inclement weather when men who are unable to work at their ordinary trades—such as those in building trades, out-of-door workers, concessionaires, etc.—find this time ideal to have their auto radios repaired.

Proper Tools

The days of removing and installing an auto radio with a pair of pliers are over. In order to do speedy and efficient work, it is necessary to have the proper tools. A trip through an auto parts store will show you the various wrenches with ratchets and deep sockets, and with these it is possible to get into the most inaccessible places with ease. We use a special ¼" ratchet wrench to remove P.K. screws and in that way are able to replace tubes and vibrators in auto radios without removing the set from the car.

Our work bench has one 6 volt battery outlet. We also have built-in PM speakers and special lugs and fittings to adapt our speakers to the various plug and jack arrangements the different manufacturers use. We do not use a stock battery eliminator because we find that this device picks up r.f. signals from the a.c. line and the set will operate better on the bench than in the car. We use regular auto antennas mounted on the work bench. You must be sure, however, to adjust the antenna trimmer after the set is installed in the car. We also use pilot lights, in series with speakers, to prevent voice coil burnout when the speaker is incorrectly plugged into the radio field coil outlet.

The extraordinary "signal-seeking" push-button sets that came out this year are very tricky, but reading the manufacturer's service manual will help in locating and repairing the trouble. They are different and unusual, but not impossible.

An extensive inventory of repair parts is a "must" for the auto radio service shop.

We have been in this business for over twenty years. We started when it was necessary to remove the roof upholstery and use screen wire as an aerial under the roof fabric of the car. Then we graduated to aerials under running boards, which is also a thing of the past. All cars now use cowl aerials or antennas through the roof. We have a set of *Greenlee* punches of various diameters and we cut a hole to mount the aerial without drilling and reaming and filing—another example of the importance of the correct tools in auto radio service. Some car manufacturers and auto aerial manufacturers supply templates to show just what spot to install the aerial so that it will clear everything underneath and stand up straight. We file these away and use them when the occasion demands, although with the new swivel top and "eight-ball" aerials they can be adjusted to almost any contour of automobile.

Auto radios require more frequent service than home radios. The reason for this is that the tubes and com-

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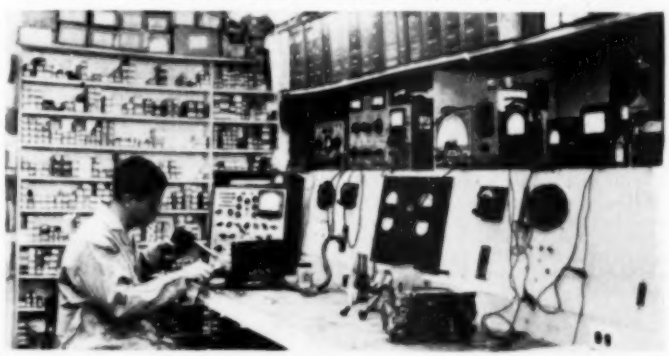
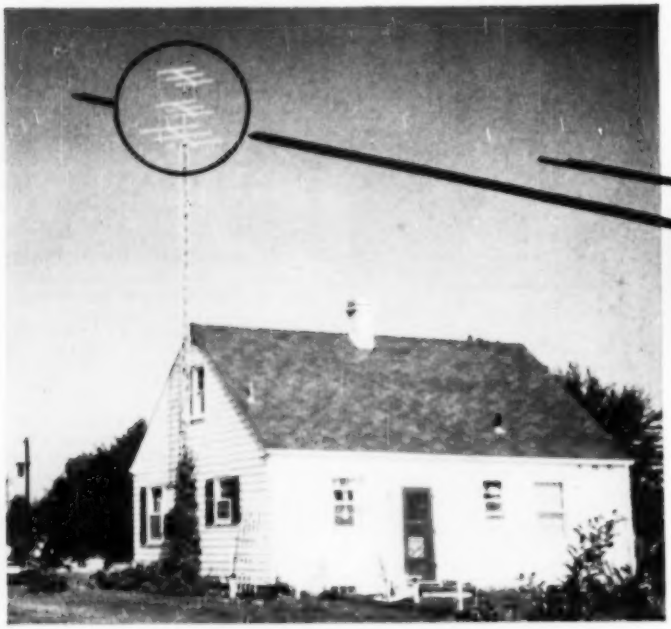
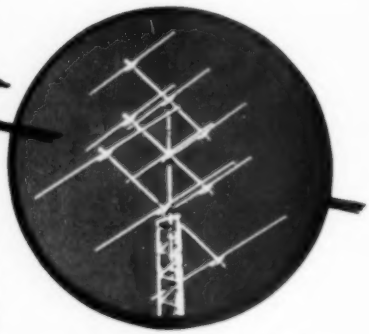
Complete and accessible test equipment is important in speeding up auto radio work.



A PHASED TV BEAM ANTENNA

By
T. A. PREWITT





Close-up view of the phased TV beam built and installed by the author.

The two-bay 144 megacycle antenna as installed atop the single-bay FM antenna in use at the author's house.

Can be built to include all TV channels, the entire FM band, and the 2 meter amateur band. Provides good TV reception within radius of 40 miles from station.

THE antenna shown in the accompanying photographs owes its existence to the present-day shortage of aluminum tubing. Although made from inexpensive, non-critical materials, it has a moderate forward gain of 4 db, a good front-to-back ratio (31 db on any one selected channel), and enough bandwidth to cover three adjacent low band TV channels, the entire FM band, or most of the high TV band with negligible loss of gain. It is light in weight, neat appearing, easily built, and surprisingly sturdy. An early model, which has been in use nearly one year, has withstood three windstorms and a small tornado without damage.

Electrically, the antenna consists of three folded-dipole elements, made of wire strung on wooden element supports. Quarter-wave lines used for phasing and impedance transformation are so adjusted that signals picked up by each of the three elements from a station in front of the antenna will add in phase, but from a station in back the signals received by the front and back elements cancel the signal received by the center element. In theory, complete cancellation of the signal from the back side is possible; practical antennas show measured front-to-back ratios of more than 30 db. At the third harmonic of the design frequency, each element is three half-waves long and the phasing lines are three quarter-waves long. These conditions approximately satisfy the requirements for proper phasing, and it will be found that an antenna cut for Channel 3, 4, or 5 will also perform quite well in the high TV band.

Best front-to-back ratio is obtained when the impedance of each of the outer elements appears to the transmission line as being twice the impedance of the center element. For mechanical simplicity, all elements are made alike, and the necessary impedance step up is obtained in the quarter-wave phasing lines. Due to coupling between elements, the impedance of the three folded dipoles is something other than their free space value of 288 ohms, and is difficult to calculate. For this reason the phasing line impedance giving best front-to-back ratio was determined experimentally. No. 18 wire spaced 3½ inches, No. 20 spaced 2¾ inches, or any other size between No. 16 and No. 24 spaced 85 times its own diameter may be used for phasing lines. Fig. 2 shows a typical field strength pattern, in this case that of an antenna cut for the FM band. Many of the measurements made during the development of the antenna were made using steady signals received from an FM station twenty miles distant. Some work was done with scale models at a frequency of 420 mc., and a laboratory generator and field strength meter were used to make still other checks on Channel 5. Similar gains and patterns were observed in all instances.

Construction of the antenna is extremely simple, and only common woodworking tools are required. Clear white pine is recommended for the boom and element supports because it withstands weather without warping or splitting. Element supports are made by ripping 1 x 2 inch stock into two 1 x 1 inch pieces. The boom used on FM, 2 meter amateur, and high TV

Correct element lengths and spacings for all TV channels, FM, and the 2 meter band.

BAND OR CHANNEL	ELEMENT LENGTH	ELEMENT SPACING
2	98	52
3	88	47
4	81	43
5	70	37
6	65	35
7	31	16½
8	30	16
9	29	15½
10	28	15
11	27	14½
12	26	14
13	25	13½
FM	54	30
2 METERS	38	20

band antennas may be a 1 x 2, while that used for larger antennas should be made of heavier stock, such as 2 x 2 (or two 1 x 2's nailed together). Three braces made from one-inch stock strengthen the joints between the element supports and the boom. Assembly is started by cutting three one-half inch deep notches in the boom, spacing them as shown in Fig. 1. The width of the notches should be carefully measured to insure a snug fit when the elements are later assembled. Next, the three braces are notched to a depth such that when held in place under the boom, the top of the brace is flush with the bottom of the notch in the boom. Again, the notches should be measured for a snug fit. Holes are now drilled and countersunk in each of the three braces, which are then fastened to the boom with one flathead wood screw in each brace. The ends of the element supports are drilled to receive the antenna conductor wires, and two holes are drilled in each element support for the screws which hold it to the brace. After the element supports have been assembled to the boom, the entire framework should be given two coats of weather-resistant paint before the wires which form the elements are added. Observe carefully the element layout shown in Fig. 3, which permits three elements and two transmission lines with only three lengths of wire. Be sure to transpose the phasing line between the center and rear elements a half-turn, keeping the spacing between conductors constant. Joints should be soldered securely. Suitable insulators may be used to stand the elements and phasing wires off from the framework, although no serious loss of performance will result if they are omitted. This is true because the ends of the element supports are at the same r.f. potential as the ends of the elements, and the only effect is a small change in impedance. The midpoint of the center element may be grounded to the mast for static protection, since this point is at r.f. ground potential. If this is done, no lightning arrester will be needed if the mast is well grounded. Since all elements are driven, the frequency response is much wider than that of a parasitic or yagi beam, and no tuning or adjusting is needed after completion if the antenna is constructed as shown.

Performance of the antenna has been quite gratifying. FM stations in Chicago, 130 miles distant, are received with satisfactory quality most of the time, while stations in Wisconsin, Michigan, Ohio, and other locations up to 250 miles distant are often heard. Either WFMF, Chicago, or WCNB-FM, Connersville, Indiana, both on 100.3 mc. may be received without interference from the other by rotating the antenna. Although they do not have the extreme gain necessary for consistent operation in fringe areas, TV antennas of this type perform well in such locations on nights when signals are strong and co-channel interference is severe. In average locations at distances of forty miles from a low-band TV transmitter, the antenna will deliver an adequate signal if installed at a height of thirty feet above ground. Multiple stacking, of course, may be used to give added forward gain without loss of front-to-back ratio.

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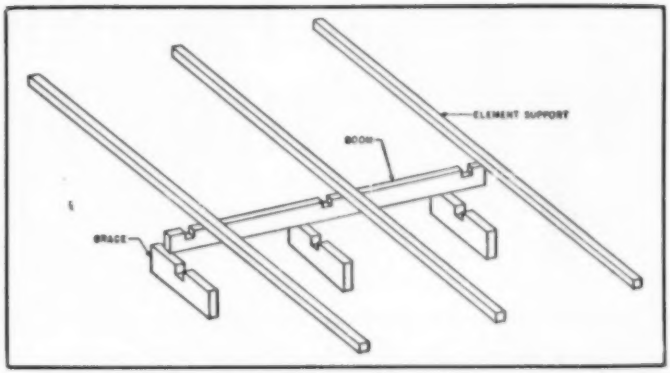


Fig. 1. "Exploded" view of the antenna frame showing how parts are assembled.

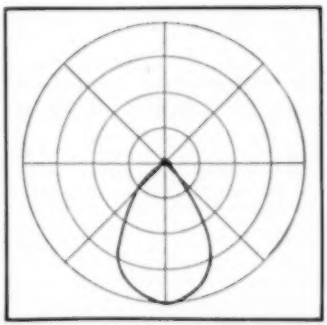


Fig. 2. Typical field strength pattern for phased TV beam antenna. Frequency is 100 mc. The generator was a Boonton 202B unit.

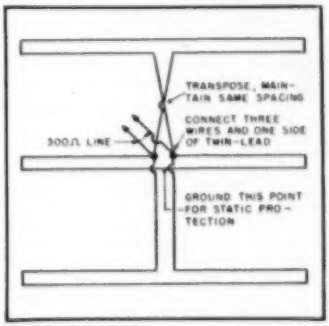


Fig. 3. Layout of the elements comprising TV beam. The phasing line between the center and rear elements must be transposed.

Pattern checks on this antenna are made using a field strength meter and a test signal generator. The antenna illustrated below is cut for Channel 5.

Low-Pass PHONOGRAPH FILTER DESIGN

By

ROBERT A. SINKER

Research Analyst
Northrop Aircraft Company

Details on an L-C-R filter designed to attenuate record surface noise. It can be used with various cartridges, including variable reluctance pickups.

THE propriety of using filters or tone controls in conjunction with a wide range high fidelity amplifier is a subject which finds considerable difference of opinion among audio enthusiasts.

One school of thought contends that the object of an ideal audio system is to create, at the ear of the listener, an exact reproduction of sounds he would hear were he listening to the original program material. This group argues that the only control which should be made available to the listener is one over power output. (The controversy of volume control vs. loudness control is purposely being side-stepped as not being pertinent to this article.) The reproduction system, according to this philosophy, should be of flat bandpass over the entire audio frequency spectrum. A high fidelity tuner and the best quality recordings are to be used to provide the signal source for this audio system in order to justify the exact reproduction.

An opposing group argues for a greater degree of listener control over the sound reproduction. They present the incontestable thesis that the ultimate object of the sound system is the entertainment of the listener. They maintain, therefore, that the listener should be able to "season" the music to his personal taste. Inasmuch as the concert goer may sit in that section of the hall which provides the most pleasant tonal balance to his ear, so the listener should be provided with tone controls to create the most pleasing balance to his ear, according to this philosophy.

The low-pass filter for phonograph systems, which is the subject of this article, does not violate the principles of either school of thought. This control provides the listener with a means of reducing the high frequency range of a phonograph system in order to attenuate the record surface noise, or "scratch." The "hands off" school of thought would have a difficult time trying to convince this writer that music full of "scratch" represents a more faithful reproduction of the original orchestra than music which has been attenuated in the high frequencies with the resultant decrease in noise level.

In the final analysis the listener chooses a sound system which provides the most listening enjoyment to him personally. This writer has a large collection of classical records which have been acquired over a period of many years. This library represents a considerable investment and many of the selections are irreplaceable. Most of the records, including all of those which cannot be replaced, are shellac base discs. The noise characteristics of these records are well known. A low-pass filter with an adjustable cut-off frequency enables a control over the frequency spectrum of the sound which provides a considerable increase in the pleasure I derive from listening to these records.

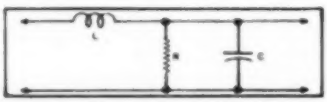
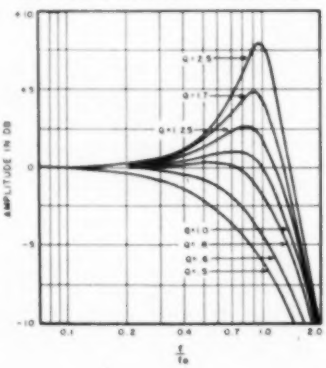


Fig. 1. A single-section low-pass filter using inductance, capacity, and resistance. A filter of this type has a sharper cut-off than the straight RC type circuit.

Fig. 2. Cut-off characteristic of low-pass filter (Fig. 1) for several values of Q.



A filter using inductance, capacity, and resistance is preferable in this application. Such a filter provides a sharper cut-off than it is possible to obtain by using only capacity and resistance elements. Fig. 1 shows the configuration of a single-section, low-pass filter using all three elements. The resonant frequency and Q of this circuit may be computed from the following well-known formulas:

$$f_o = \frac{1}{2\pi\sqrt{LC}}$$

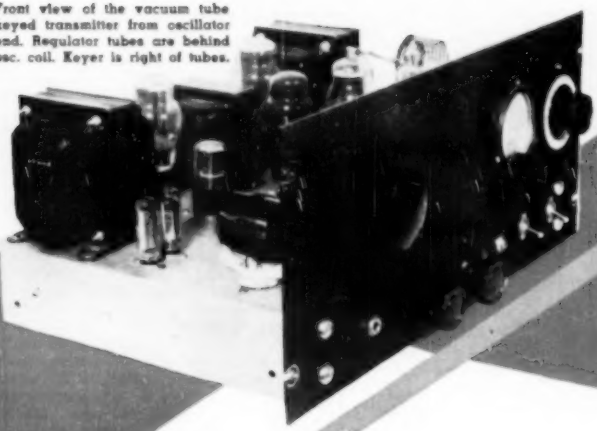
$$Q = \frac{R}{2\pi f_o L} = 2\pi f_o C R$$

Fig. 2 is a graph showing the characteristics of this low-pass filter circuit in the vicinity of the resonant frequency, for several values of Q. The frequency has been plotted as the ratio of the applied frequency to the resonant frequency in order to make the presentation independent of the resonant frequency of a particular filter. It can be seen that a Q of 2.5 results in an undesirable peak in the response at the resonant frequency, while a Q of 0.5 results in too gradual an attenuation curve. The response of the filter with a Q of 1 provides a sharp cut-off while limiting the resonant rise to a negligible one decibel. Specifying a value of one for Q allows a simplification of the second equation to:

$$R = 2\pi f_o L$$

High quality audio inductors are considerably more expensive than resistors and condensers. They also have an annoying tendency to increase the hum level by coupling to stray magnetic fields from heater and "B" supply circuits. However, those record players which use variable reluctance pickups already contain an inductance suitable for use in the low-pass filter of Fig. 1. A variable reluctance pickup is equivalent to a voltage generator in series with the self inductance of the pickup. By shunting a resistor and condenser across the input to the pre-amplifier, the inductance of the vari-

(*Continued on page* 107)



Front view of the vacuum tube keyed transmitter from oscillator end. Regulator tubes are behind osc. coil. Keyer is right of tubes.

A Vacuum Tube KEYED TRANSMITTER

A compact transmitter for c.w. hams. It includes a break-in system and can be adapted for phone.

By
JACK D. GALLAGHER, W5HZB

A LARGE majority of the transmitters which have been described in various radio magazines provide a real stimulus for prospective builders. There are band-switching transmitters, single-control transmitters, two control transmitters, and just plain "rigs." Either c.w. or phone, or both is used in all of them. If c.w. is used, the method of keying varies from cathode keying, screen keying, primary keying, grid-block keying to vacuum tube keying. If phone is used, the methods of modulation vary from frequency modulation, plate modulation, screen modulation, grid modulation, to clamp-tube modulation.

If the reader is a c.w. ham only, he will scan the various c.w.-phone transmitters and see how he can vary them for strictly c.w. operation. If he likes both, he will dislike something about the c.w. keying arrangement provided, or he will want to modify the modulator to suit his needs. If he is a phone man, he will disregard the method of keying entirely and concentrate on the modulation method used and change it or leave it alone.

It is not the purpose of this article to present a complete all-band phone-c.w. transmitter for the beginner or the "old timer." It is hoped, however, that the transmitter to be described will provide a compact rig with clickless, chirpless keying for the c.w. ham; can be adapted for any type of modulation; and will provide a keyer for break-in operation for c.w., or will eliminate the standby switch for either phone or c.w. Such a transmitter, if properly designed, can incorporate clickless, chirpless keying and all of the other features just mentioned without causing undue hardship for the potential builder.

A Clapp oscillator was chosen for its stability and one-half of a 12AU7 was wired as such. To isolate the oscillator from the following stages, the second section of the 12AU7 was used as a cathode follower. To boost the output, a 6AC7 was employed as an amplifier-doubler. The remainder of the transmitter is straightforward. A 6V6 can be substituted for the 6AQ5 with very few circuit modifications. Either one or two 807's can be used depending on the desired output.

A 5" x 5" area on the 12" x 17" x 3" chassis was allotted to the v.f.o. All other components both above and below the chassis were kept clear of this area until it was found that shielding the oscillator was not necessary.

After the transmitter was completely wired and ready for testing, various keying methods were tried. The first type was cathode keying of the 6AC7 amplifier stage. This method was ruled out immediately upon hearing the oscillator running when the key was not closed and noticing a perceptible click in keying characteristics.

The second method of keying tried was keying the cathode follower stage alone. Again, poor results were ob-

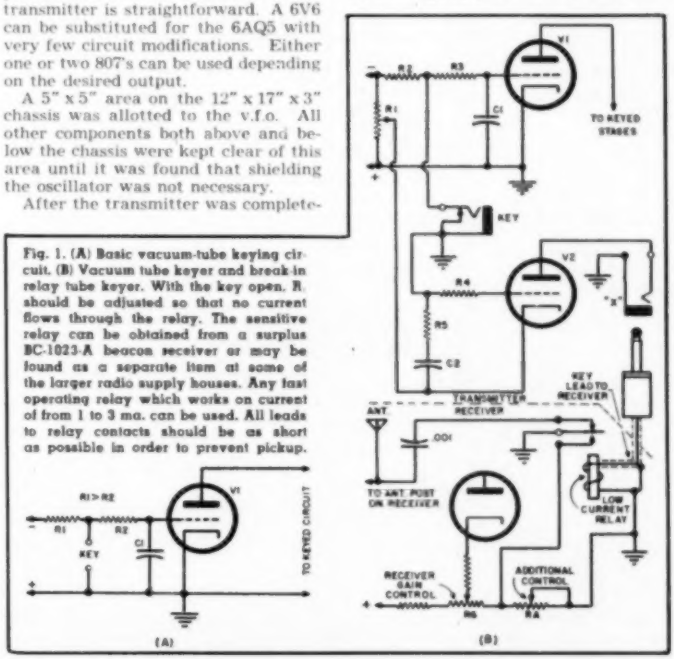


Fig. 1. (A) Basic vacuum-tube keying circuit. (B) Vacuum tube keyer and break-in relay tube keyer. With the key open, R should be adjusted so that no current flows through the relay. The sensitive relay can be obtained from a surplus BC-1023-A beacon receiver or may be found as a separate item at some of the larger radio supply houses. Any fast operating relay which works on current of from 1 to 3 ma. can be used. All leads to relay contacts should be as short as possible in order to prevent pickup.

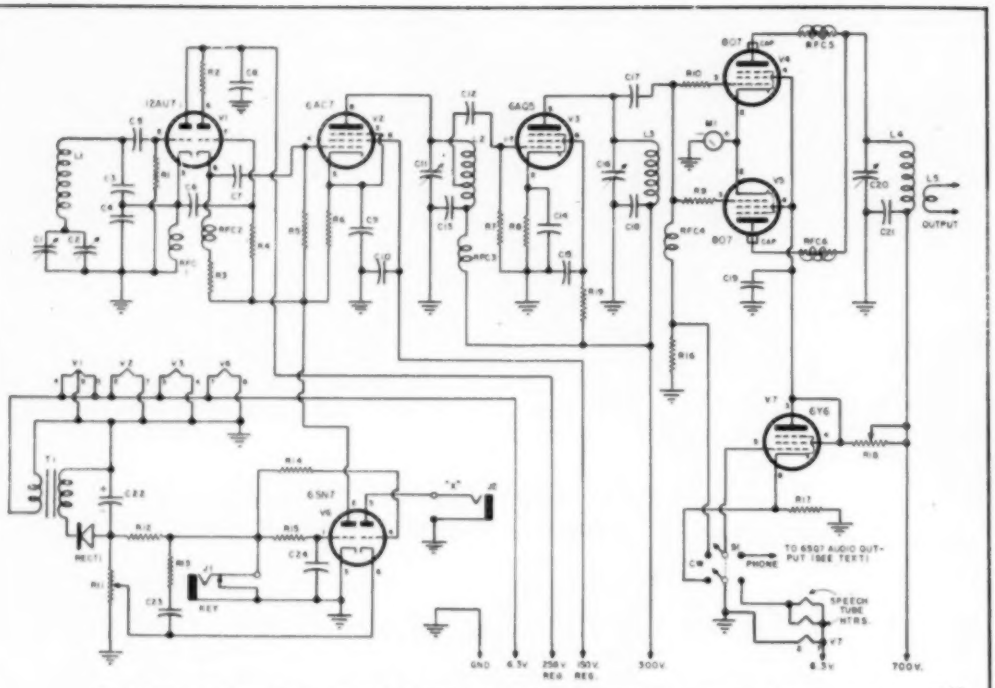
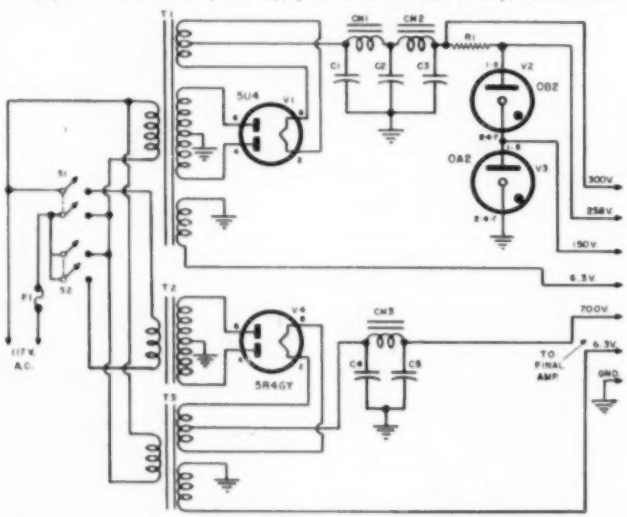


Fig. 2. Complete schematic diagram of the vacuum-tube keyed transmitter including operating frequency chart.

Fig. 3. Schematic of the power supply unit to be used with v.f. keyed transmitter.



R_1—2000 ohm, 10 w. wirewound res.
C_1—15 μfd., 500 v. elec. cond.
C_2—10 μfd., 500 v. elec. cond.
C_3—20 μfd., 450 v. elec. cond.
C_4, C_5—2 μfd., 1500 v. oil filled cond.
S_1, S_2—D.p.s.t. sw.
F_1—3 amp., 117 v. line fuse
T_1—Power trans., 350-0-350 v. @ 90 ma.; 6.3 v. @ 3.5 amps; 5 v., c.t. @ 3 amps.
T_2—Plate trans., 650-0-650 v. @ 200 ma.
T_3—Fil. trans., 5 v., c.t. @ 3 amps; 6.3 v. @ 3.6 amps.
CH_1—8 hy., 90 ma. filter choke
CH_2—5 hy., 90 ma. filter choke
CH_3—10 hy., 200 ma. filter choke
V_1—5U4 tube
V_2—OB2 tube
V_3—OA2 tube
V_4—5R4GY tube

Freq. Output	L_1	L_2	L_3	L_4
80	160	80	80	80
40	160	80	80	40
	160	80	40	40
20	160	80	40	20
	80	80	40	20
	80	40	40	20
	80	40	20	20
10	80	40	20	10

This chart shows the different coil combinations which work successfully with transmitter. For optimum results, L_1 should be an airwound coil.

R_1, R_2—100,000 ohm, 1 w. res.
R_3—12,000 ohm, 1 w. res.
R_4—1200 ohm, 1 w. res.
R_5, R_6—500,000 ohm, ½ w. res.
R_7—150 ohm, ½ w. res.
R_8—50,000 ohm, 1 w. res.
R_9—400 ohm, 1 w. res.
R_{10}, R_{11}—47 ohm, 1 w. res.
R_{12}—100,000 ohm pot
R_{13}—1.2 megohm, ½ w. res.
R_{14}—150,000 ohm, ½ w. res.
R_{15}—6.8 megohm, ½ w. res.
R_{16}—20,000 ohm, 10 w. wirewound res.
R_{17}—1250 ohm, 10 w. wirewound res.
R_{18}—25,000 ohm, 25 w. wirewound var. res. (See text)
R_{19}—25,000 ohm, 10 w. wirewound res.
C_1, C_{11}, C_{12}—100 μμfd. var. cond. (APC type)
C_2—50 μμfd. var. cond. (APC type)
C_3, C_4—.001 μfd., 500 v. silver mica cond.
C_5, C_6, C_7, C_{13}, C_{15}—100 μμfd. mica cond.
C_8, C_9, C_{10}, C_{14}, C_{16}, C_{17}, C_{19}—.01 μfd., 400 v. cond.
C_{18}—.001 μfd., 1000 v. mica cond.
C_{20}—100 μμfd. var. cond., .070" spacing
C_{21}—.01 μfd., 2000 v. mica cond.
C_{22}—40 μfd., 150 v. elec. cond.
C_{23}—.05 μfd., 200 v. cond.
C_{24}—.004 μfd., 400 v. cond.
RFC_1, RFC_2, RFC_3, RFC_4—2.5 mhy. r.f. choke
RFC_5, RFC_6—See text
M_1—0-200 ma. d.c. meter
T_1—Fil. trans., 6.3 v., @ 1 amp.
Rect.—75 ma. selenium rectifier
J—Key jack
J—Jack (See Fig. 1B)
S_1—D.p.d.t. sw.
V_1—12AU7 tube
V_2, V_3—807 tube
V_4—6AC7 tube
V_5—6SN7 tube
V_6—6AQ5 tube
V_7—6Y6 tube

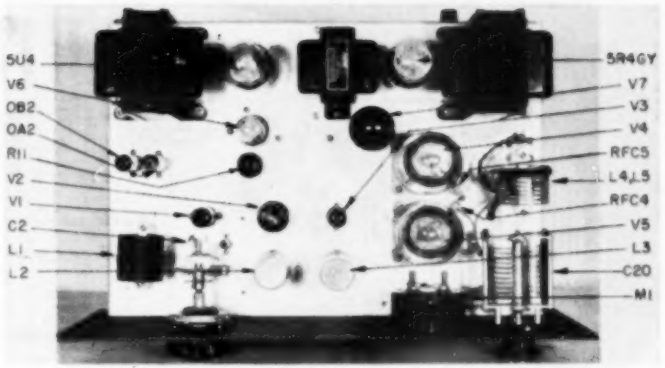
tained because the 6AC7 amplifier stage picked up enough of the oscillator to cause it to be heard when the key was open. Keying characteristics were superior to those found when using cathode keying in the 6AC7 amplifier stage. In both of these cases, the oscillator was running continuously on 160 meters with the final on 40.

At this point, it was decided that a suitable means of keying should be incorporated in the transmitter. Experiments proved that both the cathode follower stage and the 6AC7 amplifier stage should be keyed to prevent amplification of the oscillator during key-up conditions. Keying the cathodes of both of these sections would be unsatisfactory because of clicks resulting from comparatively large keying currents. After trying innumerable keying filters and other methods of keying as well, a vacuum-tube keyer seemed to be the logical answer to the problem. Excessive keying currents could be eliminated quite easily by this method; however, the known types of vacuum tube keyers required a power supply and two or three tubes. Further investigation revealed that a small triode could be used to accomplish cathode keying if changes were made in the original circuit.

To eliminate a cumbersome power supply on an already "full" chassis, a 6.3 volt, 1 ampere filament transformer was selected to furnish the necessary voltage for the keyer tube. A small selenium rectifier supplied the necessary d.c.

The basic circuit of a vacuum tube keyer is shown in Fig. 1A. The negative voltage keeps the keyer tube beyond cut-off with the key up. When the key is closed, the grid voltage becomes zero by discharging C_1 through R_3. When the key is opened, C_1 charges through R_1 and R_2. Thus a desirable keying characteristic is achieved in that the "make" time is shorter than the "break" time.

In order to provide break-in operation, some means of shutting off the receiver before the transmitter is keyed and turning it on after the transmitter has been keyed, must be made. The schematic shown in Fig. 1B will serve the purpose quite well. Its explanation is as follows: With the key open, V_1 does not conduct because of the high bias on its grid. V_2 does not conduct because its grid is more negative than its cathode. When the key is closed, V_2 conducts first because its grid is made positive with respect to its cathode. The cathode side of C_2 is negative with respect to the grid of V_3. V_1 conducts next because C_1 is discharged through R_{1a}. When the key is again opened, V_1 stops conducting because of the high bias immediately placed upon its grid. V_2 will stop conducting after the cathode side of C_2 has become positive with respect to V_2's grid. The amount of delay between the time the key is opened and V_2 stops conducting can be easily increased by increasing the values of C_2 or R_{2a} or both.



Top chassis view of transmitter showing layout. T, (Fig. 3) is at upper left. R, shown in the diagram of Fig. 1B, is below keyer tube. The final power supply occupies upper right hand third of chassis. See Fig. 2 for identification of parts.

A sensitive relay is placed in the plate circuit of V_2 to shut the receiver off by the Rice method as shown in Fig. 1B. This method was developed by Henry E. Rice, Jr., W1PMT, and has been the simplest, fastest break-in system found by the author. In Mr. Rice's original circuit, the transmitter was keyed by the relay which required a battery. Another key lead was also needed from the relay to the transmitter. Here, the entire vacuum-tube keyer and relay keyer tube is incorporated in one tube in the transmitter. Only one pair of wires to the receiver is needed to control the relay, while the keying lead to the cathode follower and 6AC7 stage is kept as short as possible inside the transmitter.

If, by chance, some other means of break-in operation has already been incorporated in the receiver, it is a simple matter to eliminate V_2 and all associated connections including the potentiometer. This will not affect the operation of V_1.

Osc. Coil
L_1—160 m.—Bud, OCL, or OEL 160 or equiv. 80 m.—Bud, OCL, or OEL 80 or equiv.

6AC7 Plate Coil
L_2—80 m.—92 t. #30 enam. wound on Millen 74001 shielded form, ½" dia., ⅞" long. Slug removed. Tap 60 t. from plate end 40 m.—47 t. #30 enam. wound on Millen 74001 shielded form, ½" dia., 1" long. Slug removed. Tap 32 t. from plate end

6AQ5 Plate Coil
L_3—80 m. & 40 m.—Identical to L_2 except coil not tapped. 20 m.—22 t. #30 enam. wound on Millen 74001 shielded form, ½" dia., 1" long. Slug removed

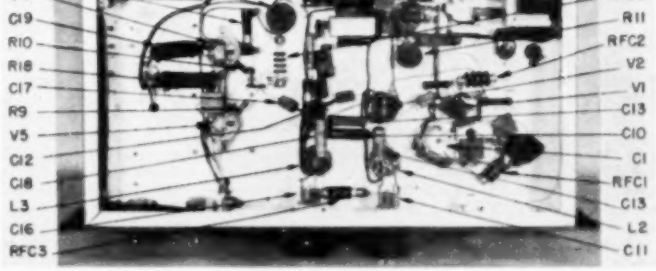
Final Plate Coils
L_4—80 m., 40 m. & 10 m.—Bud, OEL 75 w. coils or equiv.

Coil data. See Fig. 2 for identification.

The adjustment of the transmitter is not complicated and no trouble should be encountered in tuning. With either one of the line switches controlling the power transformers turned "On," all filaments will be on and plate voltage will be applied to all stages except the final. With the oscillator

(*Continued on page* 110)

Bottom view showing oscillator section at lower right. All of the a.c. power wiring is held close to chassis at extreme left. The oscillator, amplifier-doubler, and buffer-doubler, power supply components are at upper right portion of chassis. Filament transformer, T, of Fig. 3, is at top center and keyer tube power supply below and to the right. For identification of parts see the diagram of Fig. 2.

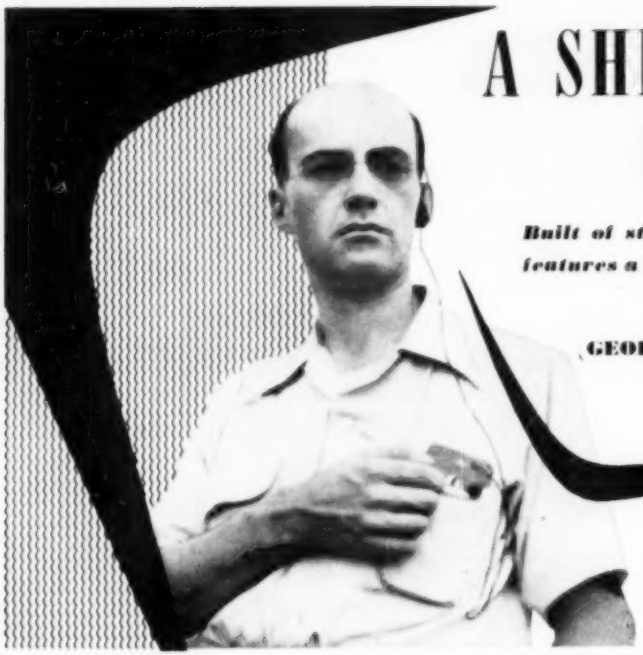


A SHIRT POCKET RADIO

Built of standard parts, this receiver features a loop antenna and low drain.

By

GEORGE L. JOHNSON, JR.
W9LQX



Separate controls for tuning and regeneration allow signals to be peaked for best reception.

POCKET radios are not new, yet the design of a truly pocket-sized set which combines real performance with simplicity of construction and extreme battery economy is new and this author believes that he has achieved such a design in the little radio described in this article.

The current drain of the set is only 140 μa. on the "B" battery and 20 ma. on the "A" battery. Under these conditions the "B" battery gives practically shelf life (about 1000 hours or one year of normal use) while the "A" battery, a ten cent penlite cell, will give about 100 hours' service. This should set an all-time low for cost-per-hour of listening as the "B" battery practically never wears out and the "A" cell, which will run the set two hours a day for a month, costs a dime.

The output voltage is ample for comfortable earphone volume on the average local (25 miles distant or less) station. For all its economy of plate current, this little radio is capable of delivering a "rattling the cans" signal on nearby stations. The over-all dimensions of the set are: 6 inches long, 3 inches wide, and ¾ inch thick—a size that will fit easily into the average shirt pocket.

The antenna is a self-contained loop wound on the outside of the case to provide approximately 18 square inches of loop pickup area. This is equal to the size of the loops found in most commercially-built "personal" portables.

Thus, we have a personal radio which may be worn, not carried. If the pocket is large enough for concealment and a hearing aid type earphone is used, the wearer may listen to the radio in a public place and no one will be the wiser! Other places for use of this set are; sports events, beaches, picnics, or one may do as the author did—catch a morning newscast while riding to work on a streetcar!

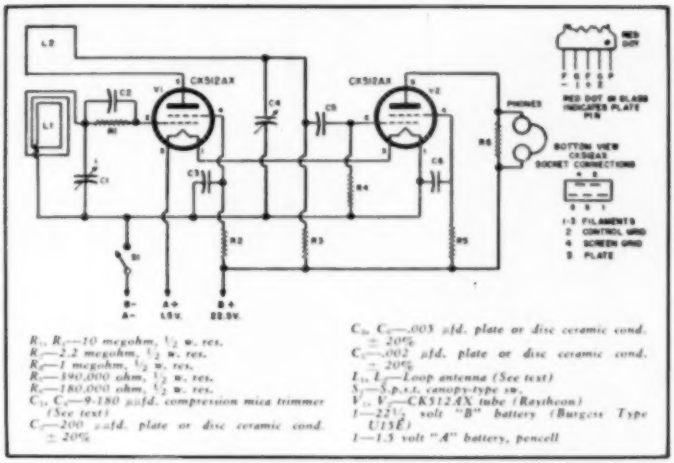
Enough of this idle chit-chat. Just what is this little marvel, you say, and how do I go about building it? Which brings us to a discussion of the circuit. To be brief, it is a pentode regenerative detector feeding a one-stage pentode audio amplifier. The main loop winding is in the grid circuit of the detector, and conventional plate feedback is applied through a small "tickler" winding, wound on top of the loop over a layer of *Scotch* masking tape. Both the detector and amplifier tubes are *Raytheon* type CK512AX flat hearing aid type voltage amplifier pentodes. They are designed for a maximum plate voltage of 22½, and each tube's nominal filament rating is .625 volt at 20 milliamps. Thus the tubes' filaments are connected in series across a single 1.5 volt dry cell for "A" supply. The "B" supply is a *Burgess* type U15E 22½ volt battery. Tuning of the set over a range of 540-1300 kc. is done with a standard 9-180 μμfd. compression mica trimmer. This is easily modified from screwdriver to knob tuning as will be described later. Control over the regeneration is accomplished by varying the amount of r.f. bypass in the plate circuit of the detector, and another 9-180 μμfd. condenser is used here. The control is very smooth and gradual to the point of maximum feedback, and the detector finally breaks into oscillation but with no "plop" or instability. As with all regenerative sets, maximum sensitivity is secured with the maximum amount of feedback obtainable without oscillation. Selectivity of the set is good, as 15 local stations in the Chicago area were easily tuned in and separated. This includes one fifty kilowatter only ten miles away.

Earphones

The earphone of the original set is a prewar vintage *Brush* single unit crystal headset. The efficiency of this type of phone is quite good, and what is more important, the high impedance of a crystal phone matches the output load impedance of the tiny CK512 tube. With such a small power output stage, it is absolutely necessary not to lose any useful audio power through poor impedance matching. Any crystal type phone, single or double unit, may be used in the set with no circuit changes. A good quality magnetic phone may also be employed with good results if the phone has high impedance. One word of caution on this. There are certain types of cheap headsets on the market now which have very low efficiency. They may require as much as three or four volts of signal across their terminals in order to deliver a good, usable signal to the ear, whereas with the crystal type one volt is plenty. Beware of the "98 cent special" phones when buying for this set. They are OK for bigger radios, but not this one. When using a magnetic type phone, the 180,000 ohm resistor in the audio plate circuit may be omitted.

Should a hearing aid "ear plug" type phone be used? Admittedly, for a pocket radio, the appeal of this type is high. It is of course the lightest in weight of all phones. The air seal from the diaphragm of the phone to

the ear drum is perfect, and so the maximum transfer of sound energy into the ear is possible. This means an apparent increase in loudness when compared to an earphone that does not plug into the ear. All this is well and good, however, hearing aid phones have certain disadvantages which it is well to consider before deciding on this type. First of all, there is the price, which may easily run double the cost of even a first class single unit crystal phone. Second, is the problem of fitting the phone to the ear of the individual concerned. In fitting a person with a hearing aid, a mold is made of the individual's ear. From this a custom fit plug is made, and of course, it fits well and is comfortable to the one person for whom it is designed. However, this is very expensive and hardly practical for pocket radio use. The average builder who tries to use a hearing aid earpiece will have to get along with a so-called "universal ear mold." These are just about as "universal" as a "universal" hat or "universal" pair of shoes would be. The phone is likely to be too loose or too tight or be uncomfortable. It may fall out at just the wrong time. It is certain to become messy due to the natural secretions of the ear, and cannot be readily passed around to friends, as one would like to do with a novel radio such as this. For these reasons, this author says of hearing aid phones—"Not recommended for the average builder." Should you decide to use one anyway, a crystal type is preferable, and if a magnetic type is used, a matching transformer to match the phone to the CK512 plate must be used. Most magnetic hearing aid plugs have about 125 ohms impedance. The CK512 operates best with 100,000 to 200,000 ohms in the plate circuit, hence the need for a matching transformer. Such a transformer is small, and may be easily incorporated into the set as there is extra space.



R_1, R_2—10 megohm, ½ w. res.
R—2.2 megohm, ½ w. res.
R_5—1 megohm, ½ w. res.
R_6—390,000 ohm, ½ w. res.
R_7—180,000 ohm, ½ w. res.
C_1, C_3—9-180 μμfd. compression mica trimmer (See text)
C_2—200 μμfd. plate or disc ceramic cond. ± 20%
C_4, C_5—.005 μfd. plate or disc ceramic cond. ± 20%
C_6—.002 μfd. plate or disc ceramic cond. ± 20%
L_1, L_2—Loop antenna (See text)
S_1—S.p.s.t. canopy-type sw.
V_1, V_2—CK512AX tube (Raytheon)
1—22½ volt "B" battery (Burgess Type U15E)
1—1.5 volt "A" battery, pencell

Fig. 1. Complete schematic diagram and parts list for the "Shirt Pocket" radio.

The Receiver Chassis

The major component parts of the receiver are mounted on a 3"x6"x3/32" bakelite board which also serves as the front panel of the cabinet. Two such boards are required, for the front and back, and together they form all the cabinet that is necessary as the sides are formed by the loop antenna and its protective cover. The corners of the plates are rounded off just a bit, to permit easy insertion into a pocket.

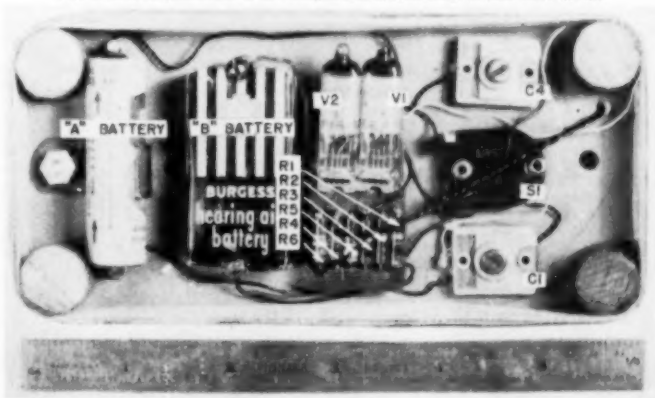
The Loop Antenna

One of the major problems in pocket radio design is *getting the signal into the set.* Conventional wire antennas are practically useless for a radio which must be carried on the person. Attempts to use the earphone cord as the antenna have been made, but the amount of signal such an antenna can deliver across the primary of an antenna coil is very small for two reasons. The most obvious is that the cord is very short. The second reason, and just as important, is that there is no ground return for a tiny chassis carried on the person. There is certainly no direct ground, and very little capacitive ground as the capacity of the person to the set and that of the person's body to the ground are effectively in series, and so the resulting capacity path is high impedance. Also, wire antennas are even less desirable for regenerative receivers, as the moving antenna causes detuning and general instability. For these reasons, the loop type of antenna, which requires no ground, is used in the majority of portable receivers.

The loop antenna L_1 is wound on a form consisting of four pieces of ⅝" dia. dowel rod ⅝" long which are nailed into place on the four corners of the main chassis with ½" carpet tacks. The main winding, which consists of 50 turns of #30 double cotton covered wire, is wound directly on the four dowels. There is not sufficient room to wind 50 turns in a single layer on the ⅝" long dowel, so the author resorted to a form of "bank winding." First, three turns are wound on the form. Then the next two turns are wound in the two grooves directly on top of the first three turns. Then the next three turns are wound on the form; the next two on top of them, and so on. Thus, the winding is composed of ten little groups or "banks" of five turns each. But only a linear winding space for thirty turns is required. This method of winding gives as low a distributed capacity as a single layer winding, yet permits almost twice as many turns to be wound in a given space. Too much distributed capacity in the loop would decrease the tuning range. Should your local stations fall in the 1300-1650 kc. range, wind the loop with eight turns less. This will make the tuning range approximately 600-1650 kc.

After the loop is wound, a coat of quick drying cement is applied to give the required rigidity. Model cement may be used for this purpose. After this cement has dried, wrap a layer

Fig. 2. Correct placement of the components is illustrated in rear view of set.



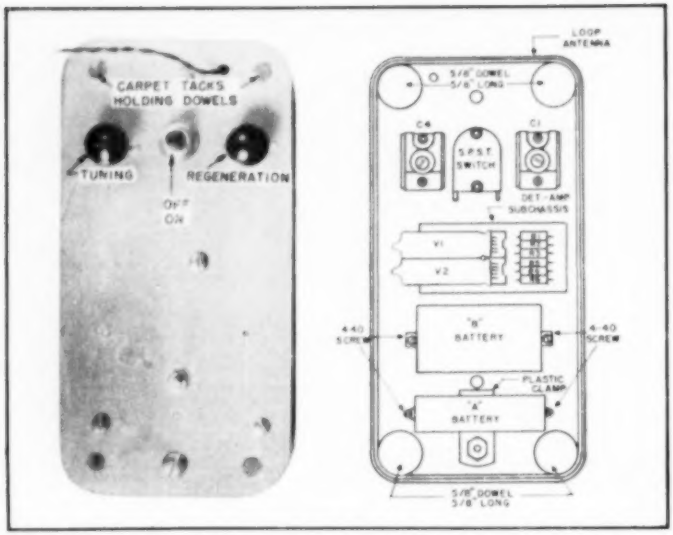


Fig. 3. Front view of the receiver (left) showing location of the various controls. Mechanical drawing indicates how the various component parts should be placed.

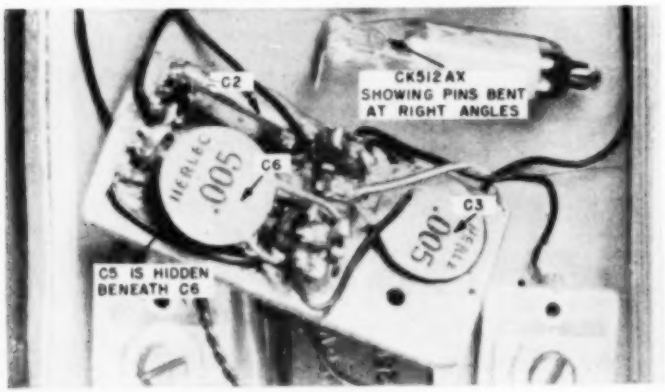
of *Scotch* masking tape around the loop to serve as additional protection, and as a base for the tickler winding L_3. This may now be wound at the filament end of the loop using 20 turns of #36 plain enameled wire, close spaced. The loop should be connected so that the end nearest the body (when the set is worn) connects to C_1. This minimizes detuning effects from the set swinging back and forth away from the body. After the tickler winding is wound, coat it with a layer of cement, and then a strip of leatherette may be wrapped around the finished loop both for protection and to give a decorative touch to the cabinet.

Modifying the Condensers

The next step in the construction of the set is to change over the screwdriver adjustment compression mica trimmers to knob tuning. First, prepare the shafts. Take a 6-32 bolt, and cut two ⅜" long pieces from it. File the ends flat and remove the burrs. Next make a center punch mark in one end of each piece, being as careful as possible to get it in the center. If a lathe is available to do this, so much the better, but a fair job of centering can be done by hand. Now drill a ⅛" deep hole with a #44 drill on the center punch marks. This hole just fits the small unthreaded end of the #3 screw in the trimmer. Place a small dab of soldering paste in the hole and a small chunk of solder (about 1/16" square) on top of the paste. Using a small hammer, gently drive the little shafts on to the ends of the trimmer screws. Place a tiny drop of oil (light machine oil) on the threads of the trimmer. This guards against any solder running down into them. Holding the trimmer in a vise, carefully align the shaft. Then apply a hot soldering iron to the free end of the shaft. If all the previous steps have been followed, the flux and solder will melt and just "sweat" the shaft into place.

For knobs, a pair of common bakelite "B" battery terminal nuts serve very well. All that is necessary is to drill and tap them for a 4-40 setscrew and screw them into place on the modified shafts.

Fig. 4. A detailed under chassis view showing the detector-amplifier subchassis.



Detector-Amplifier Subchassis

The two tubes and their associated small resistors and condensers are mounted on a 1" x 2" piece of 1/16" bakelite. The holes for the tube sockets are first drilled, then filed to size, and the sockets are cemented in place with model cement. The resistors are mounted by bending their leads at right angles, poking them through small holes in the bakelite board, and then crimping and clipping them off on the opposite side. They make a fine little terminal board for this size chassis. The ceramic condensers are mounted by their wire leads, and lie flat next to the board. Wiring may be done with an ordinary 100 watt iron, but it is best to provide a small tip for the iron to facilitate a neat job. For hookup wire, the #30 d.c.c. used in the antenna serves well and is fairly easy to handle, as the bare copper wire tins easily. The wiring layout is not critical. No particular precautions must be taken as to lead length or dressing, and this makes the electrical end of building this set quite easy. Concentrate on doing a sound mechanical job and the rest will take care of itself.

Final Assembly

After the subchassis is finished, it is laid in place and the leads from the batteries, loop, switch, and tuning condensers are wired in. Then it is fastened to the main chassis board with a single 4-40 screw and ¼" spacer. The 4-40 screw fits into a tapped hole in the subchassis board (see photo). The trimmer condensers are mounted to the main chassis by their own crimp lug mountings. The "B" battery is bolted into place with two 4-40 bolts and then the leads are soldered to it. A plastic cable clamp is used as the holder for the "A" cell, which makes its contacts to a pair of 4-40 screws fastened to the main chassis. The earphone lead feeds in through a small hole in the front of the case. Connect it up, bolt on the "back" of the case, and the set is complete.

Tuning the Receiver

The sensitivity of the set is such that, if it has been properly built, nearby stations should be heard at once. Some degree of volume will be obtained even if the regeneration control is not set for maximum sensitivity. In fact, on the original set, station WCFL (seven miles from the author's home) is so loud that no regeneration

(*Continued on page* 94)

HIGH-SPEED TANDEM WINDING MACHINES

By

SYLVAN A. WOLIN

Vice Pres., Pyramid Electric Co.

Tandem paper-condenser winding machine makes possible the mass production of uniform condensers.

Machine seals metal-glass ends of capacitors to tubular metal cases. Open U-shaped loop, in which ends of cases are placed individually, is fed by 3 kw. of r.f. energy at 3 mc.

NEW refinements in condenser production equipment have played a great part in increasing plant output. The tandem paper condenser winding machine in daily use at *Pyramid Electric* is one of the best examples of mass-production processes now in use. Its rate of output is four times greater than that of previous machines, with no sacrifice in the accuracy or quality of the finished product.

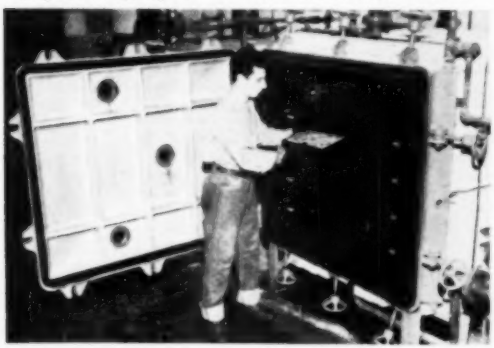
In production, a very close tolerance is maintained during long runs of condensers ranging from .001 to 1.0 microfarad. From the standpoint of the eventual users of such units—manufacturers, service technicians, experimenters, and amateurs—these advantages spell economy and reliability. Conventional paper condensers are rolled-up "sandwiches" of two layers of metal foil separated and covered by several layers of high-quality dielectric paper. In the non-inductive type, the layers of foil are offset alternately on the paper. When the "sandwich" is rolled completely, foil sticks out from both ends of the tight little roll, and pigtail wires are soldered to them. In the inductive type, the layers of foil are centered on the paper, and special pigtails or tabs are inserted between the foil and paper during the winding operation. In both cases, the relative position of foil and paper must be maintained precisely or the capacitance would then be something other than the desired value. Also, if during the winding operation either foil or paper were to become wrinkled, this would result in loss of life characteristics, "shorts" in production, and other evils. In the new winding machines, the long, curved channels guide both foil and paper accurately to the winding head so that the sections wind freely and properly thus guaranteeing units free from wrinkling and its resultant problems.

Starting the production procedure, the operator adjusts levers which begin the winding operation. Then an automatic mechanism stops the winding head when the prescribed number of turns for a particular capacitance have been wound. Actually, since each machine has been designed for dual winding, each operator produces two condenser sections during each single winding operation.

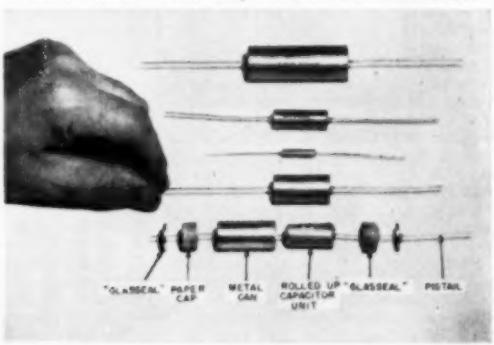
Many of the condenser sections coming off the new machines are being put into tubular metal containers with special metal-glass ends. These hermetically-sealed units, because of their extremely small size and weight and their excellent electrical characteristics over a wide range of temperatures, are in great demand for ultra-compact military equipment.

The glass discs through which the terminal wires pass are fitted with outer rings of (*Continued on page* 111)

Large vacuum oven in which capacitors are dried and then impregnated. Capacity of this oven is several thousand units.



Typical (Pyramid) "Glasseal" capacitors. At the bottom is an unassembled unit; immediately above it is an assembled one.



A V.T.V.M. ADAPTER

Front panel view of v.t.v.m. adapter. All controls are mounted to front flange of a metal box measuring 7 x 6 x 3 inches.

By
IVAN L. JOY, W6KKR

A completely battery-operated test unit that connects directly into your present multimeter. The adapter has 11 megohms input impedance and voltages as low as .125 volt can be measured.

THE need for an electronic voltmeter, combined with the necessity for economy, resulted in the development of this simple circuit which may be used with the type of meters most technicians have on hand.

A vacuum tube voltmeter which had a sufficiently low range cost more than the author was willing to spend so he decided to build an "adapter" for his present multimeter.

After the decision was made, experimentation was begun using various direct current amplifier circuits. It was necessary to keep the amplifier compact and simple yet maintain its linear amplification so that the existing meter scale could be used without alteration. The circuit described herein seems to meet the requirements.

The vacuum tube voltmeter adapter gives a conventional multimeter an input impedance of 44 megohms. The simplicity of the circuit permits the use of the scales already incorporated in the meter by adjusting the linearity control and then setting the calibration control.

Batteries are used to provide complete isolation for the adapter. The filaments are lighted with a small lantern battery and the plate current is supplied by two small 45 volt batteries in parallel. If the builder experiences any difficulty in securing sufficient amplification after the circuit has been made linear, it may be necessary to connect the batteries in series. Battery drain is only 7.5 mils.

The multiplier for the adapter should be chosen for the meter with which it is to be used. The *Triplett* 625-NA, with which this adapter was employed, has a 50 μa. movement and with the meter set in the 50 μa. position, it takes .125 volt to the input of the adapter to give full-scale deflection of the meter. It is better to select a voltage for the multiplier that is higher than that required since any over-deflection can be adjusted by means of R_{11}. The formula for determining the various resistors is:

$$\frac{R}{E_i/E_g} = R_m$$

where:

R is the input resistance chosen or the total resistance of all the multiplier resistors,

E_i is the voltage input to be measured,

E_g is the grid voltage necessary to give full-scale deflection of the multimeter chosen, and

R_m is the resistance from the E_i point on S_1 to ground.

For example, to select the 500-volt-to-ground resistor for a 50 μa. meter, the values substituted in the formula would be:

$$\frac{44 \text{ megohms}}{500/.125} = 11{,}000 \text{ ohms}$$

The resistor between the 50 volt point and ground is 110,000 ohms. Since there are 55,000 ohms in the circuit from the 100 volt point to ground, 55,000 ohms should be inserted between the 50 volt point and the 100 volt point. With 60 μa. meters the value for E_g in the formula should be .2 and for 100 μa., meters .3 should be used. The overall input resistance can be chosen to fit the type of resistors you plan to use The total input resistance could very well be 40 megohms if desired.

The batteries, tubes, and multiplier resistors are mounted in a metal box measuring 7" x 6" x 3" as this will provide sufficient room for the various components required. The unit can, however, be built in any convenient sized box which will hold the batteries the builder has on hand. On the low scales there will be some pickup from the leads in the presence of a.c., therefore, it is best to have the unit shielded in a box which is grounded to the circuit being tested.

Care should be taken so that the leads do not touch the metal box when the multimeter is connected to the adapter. If one of the leads should touch the metal while the second lead is plugged in and the meter is on the 50 μa. position, the meter is liable to be damaged.

Adjusting the Unit

From several flashlight cells select two units whose voltages are the same, as measured without the adapter connected. Next connect the adapter to the multimeter with the multimeter range switch turned to 10 v. This will protect the meter in case R_{11} should be badly out of adjustment.

Set R_{11} so that the meter reads zero, then change the multiplier switch to the 50 μa. position. Should the meter be the type that reads 100 μa. on the lowest range, use this position with the multiplier designed for use with this particular meter.

Turn the adapter multiplier switch to the 5 volt position and measure the voltage of one cell, using the adapter, and then the voltage of the two cells in series. If the reading of the two cells is less than twice the voltage of a single cell, R_{11} should be decreased, giving less bias. Should the reading be more than twice the value of a single cell, R_{11} should be increased, thus increasing the bias. After R_{11} is carefully adjusted, three cells and three linear points can be used.

After R_{11} is all set, the next adjustment is R_{14}. Connect a known source, such as 3 volts, with S_1 set on 5 volts. Adjust R_{14} so that the meter reads 3 volts on the 5 volt scale. This adjustment takes care of calibration for all d.c. ranges and the adapter is ready for use on d.c. voltages.

It may be well to have more than two 3Q4's on hand when setting up this circuit as they are not too well matched as a rule. Ordinary carbon resistors were used in the construction of the adapter but it would be possible to use precision units if the builder wants the added accuracy possible with such components.

To measure a.c. volts, turn the multimeter to 2.5 volts a.c. and throw switch S_2 so that it opens and puts R_{10} in the calibration circuit. Resistor R_{10} is the calibration resistance and can be chosen by measuring a known a.c. voltage, such as filament voltage. Set the adapter multiplier switch to the 1 volt position, which represents 10 volts a.c. A multimeter with a 10,000 ohms-per-volt input requires a 33,000 ohm resistor in order to provide the proper reading. Perhaps the easiest way to establish the value of R_{10} is to connect a 50,000 ohm potentiometer across S_2 in place of the fixed resistor and adjust the pot so that the meter reads 6.3 volts on the 10 volt scale of the multimeter with the adapter set at the 1 volt position. Next measure the potentiometer and replace it with a resistor of the correct value. If desired, the potentiometer for this adjustment could be mounted and left in the circuit. This adjustment calibrates all a.c. ranges and the adapter is ready for use on a.c. voltage.

Using the Adapter

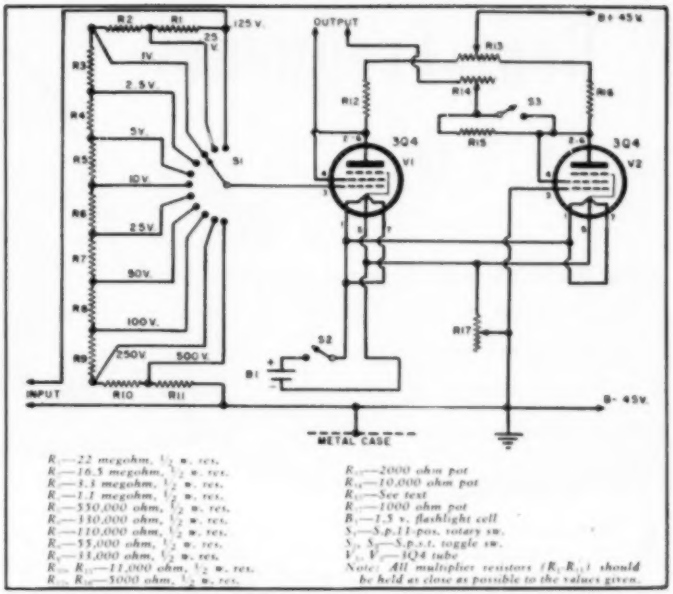
In actual use the operation of the meter is straightforward. For example, to measure a.v.c. voltage, set the multimeter on 50 μa., turn the adapter multiplier to 10 volts, close S_1, connect the negative lead from the adapter to the ground of the receiver, then connect the positive lead of the adapter input to the a.v.c. voltage and read d.c. volts on the d.c. 0-10 volt scale. Change the leads on the multimeter for deflection to the right rather than using the positive adapter input lead to the ground connection of the work as stray pickup will be apt to affect the readings.

To use the adapter for a.c. volts, change the multimeter switch to the 2.5 volt a.c. position, open S_1, and set the adapter multiplier switch to 10 volts for 100 volts, 50 for 500, etc. Be sure to take the a.c. reading on the a.c. scale of the multimeter. The a.c. volts can be read from the grids or plates of an audio amplifier without disturbing the circuit with any appreciable load. When this can be done, voltage gain on any stage can be easily determined.

One observation made was to get .4 full-scale deflection from a high impedance dynamic microphone by using the adapter with S_1 in the d.c. position and the multimeter in the 2.5 volt a.c. position. This gives more gain but gives erroneous readings on the multimeter. Nevertheless it is possible to go through an audio circuit, starting at the microphone or phonograph pickup, checking the voltage gain of everything. With the adapter set on the .125 d.c. position, voltage as low as .0025 volt represents one division of the 50 μa. scale. With the adapter set on .125, S_1 closed, and the multimeter set on 2.5 volts a.c., the lowest voltage reading will be about .005 volts.

This adapter can be used as a preamplifier for an oscilloscope or an audio amplifier as it is very linear. Should it be necessary to measure smaller voltages, two such amplifiers can be used in series and linearity maintained as long as the amplifiers are not overloaded.

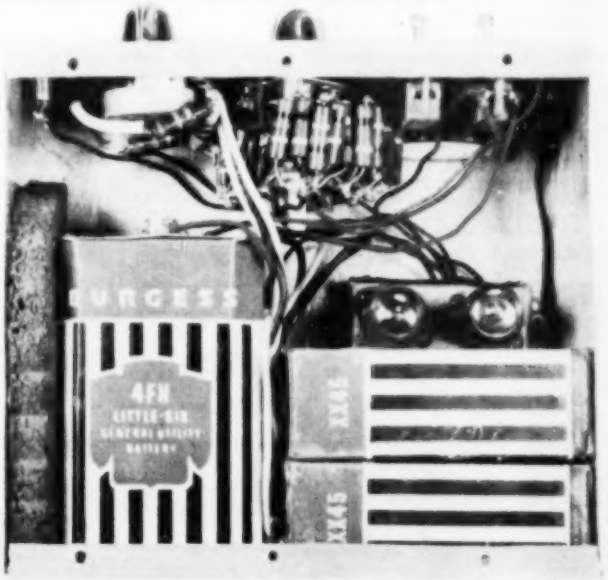
—30—



R_1—22 megohm, ½ w. res.
R_2—16.5 megohm, ½ w. res.
R_3—5.5 megohm, ½ w. res.
R_4—1.1 megohm, ½ w. res.
R_5—330,000 ohm, ½ w. res.
R_6—330,000 ohm, ½ w. res.
R_7—110,000 ohm, ½ w. res.
R_8—55,000 ohm, ½ w. res.
R_9—11,000 ohm, ½ w. res.
R_{10}, R_{11}—11,000 ohm, ½ w. res.
R_{12}, R_{16}—5000 ohm, ½ w. res.
R_{13}—2000 ohm pot
R_{14}—10,000 ohm pot
R_{15}—See text
R_{17}—1000 ohm pot
B_1—1.5 v. flashlight cell
S_1—S.p.11-pos. rotary sw.
S_2, S_3—S.p.s.t. toggle sw.
V_1, V_2—1Q4 tube
Note: All multiplier resistors (R_1-R_{11}) should be held as close as possible to the values given.

Circuit diagram of the vacuum tube voltmeter adapter. It is versatile to the extent that it can also be used as a preamplifier for an oscilloscope or audio amplifier.

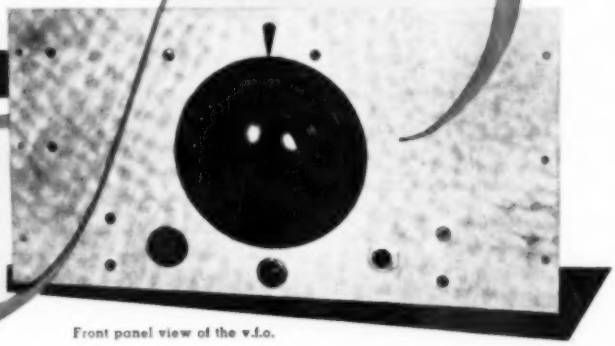
View of completed v.t.v.m. adapter. All components are mounted under the chassis.



A Beat-Frequency V.F.O.

By
H. W. KLINE
W2DKE

For the ham—complete details on a reliable unit. This v.f.o. has the stability of a crystal controlled oscillator circuit.



Front panel view of the v.f.o.

A BEAT-FREQUENCY oscillator for transmitting on any frequency within the harmonically related amateur bands and with stability equal to that of crystal control has been in use at W2DKE, Schenectady, N. Y., for over a year. Its reliability and performance have been found to be entirely satisfactory.

Modern requirements for communication demand that the frequency regulating section of the transmitter have certain fundamental operating characteristics not needed in the past. Such features are particularly important where the transmitter is used for telegraphic transmissions. For amateur transmissions the important features are as follows:

1. The transmitter must be instantly operative for high speed, break-in transmissions during the process of receiving.

2. The keying time constant of the keyed portion of the transmitter should be such that five letter code groups up to 60 or 70 groups per minute may be switched.

3. The oscillator, used for maintaining the desired carrier frequency, should be easily tunable and run continuously; should not be keyed; and, should in no way be reacted upon by the keying process.

4. The carrier frequency should change no recognizable audio-frequency amount to the human ear when heterodyned by either a local, low sensitivity monitor or by a distant, high sensitivity receiver.

5. There should be no recognizable clicks or thumps either leading or lagging an "on" increment of carrier.

6. No fundamental or harmonic signals should be present from a v.f.o. that might be picked up within the desired communication bands on a sensitive communications receiver.

In the past it was found that a transmitter oscillator could not be left "on" continuously while receiving on the same frequency. A continuous signal was obtained from the oscillator which could not be satisfactorily reduced except through the expedient of total shielding of the oscillator. It was found that total shielding of the oscillator was next to impossible or at least a satisfactory approach was expensive.

When keying an oscillator employing a self biasing circuit certain disadvantages are inherent. The starting of an oscillator requires an excessive slug of plate current because at the instant of starting, the oscillator tube has no initial bias and it draws a surge of saturation plate current. Attempts to limit this surge of current result in other complications which either alter or add something to the desired response. For this reason it is desirable to design a v.f.o. so that it may be run continuously while keying is accomplished at other points in an exciter.

The beat-frequency v.f.o. employs two oscillators. The oscillators can run continuously without any interference to reception. The unit can be keyed for the fastest break-in operation. Frequency drift has been found to be negligible and the over-all operation is thoroughly reliable. It provides output at 1 watt level, 300 ohms impedance over a frequency band of 3.5 to 4.0 megacycles.

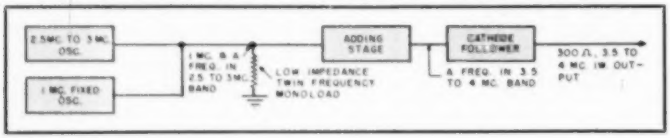
Cathode follower output at 300 ohms impedance was decided upon so that lines to amplifiers or multipliers could be made from cheap TV receiver transmission line. The unit can be coupled to many existing transmitters simply by removing the crystal and oscillator tube and connecting a small coil across the end of the 300 ohm line (which may be of any length) and placing this coil in the former crystal oscillator tank coil.

One of the oscillators employed operates at a constant frequency of 1 megacycle while the other is tunable over a band of 2.5 to 3.0 megacycles. A novel feature, which greatly increases the stability of the unit, is that of using a twin triode for both oscillators. This feature plus those of regulated plate voltage, oscillator coils of approximately equal physical dimensions, and selected oscillator circuits, were responsible for the high degree of stability obtained.

An investigation of self-oscillators over a period of time showed that two oscillators tended to drift in such manner that the sum frequency remained substantially constant. Long period drifting was due to changes in ambient conditions while short period drifting was due to changes in the tubes. It was found that when the tube elements were contained within a common envelope, short period drifting became negligible while room or ambient temperatures caused little change. A block diagram, Fig. 1, shows a general arrangement of the v.f.o.

The frequencies selected were those believed to give the least harmonic response in any of the amateur bands thus allowing the oscillators to be run continuously. Tests with a sensitive communications receiver actually showed no interference on any har-

Fig. 1. Block diagram showing the general arrangement of the beat-frequency v.f.o.



monic multiples that might occur within the amateur bands.

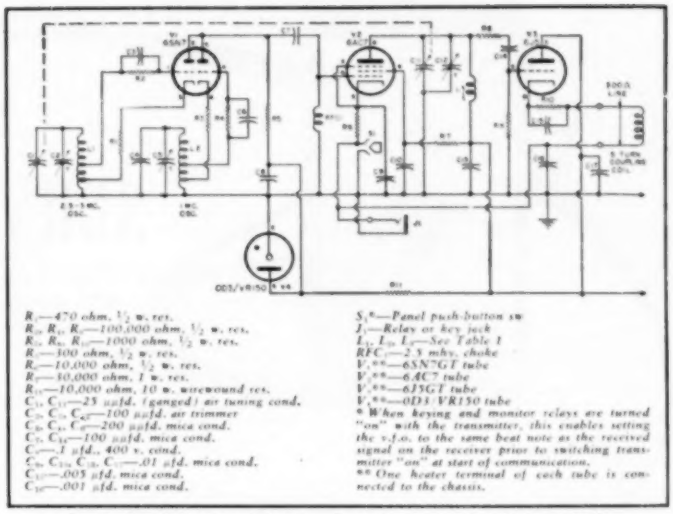
Fig. 2 shows the wiring of the v.f.o. less a conventional power supply. Either oscillator circuit is similar to the well-known *Lampkin* circuit which differs from the *Clapp* circuit in that the grid and cathode are tapped to low reactance points in the inductance branch of the tank circuit rather than to low reactance points in the capacitive branch of the tank circuit. Degenerative resistors are inserted in series with the cathodes to improve waveforms and substantially reduce harmonic outputs.

The "monoload" is a single resistor common to both oscillators or both frequencies. Its chief purpose is to allow the ouputs of the oscillators to be combined and extracted simultaneously, without any reaction between the oscillators. Usually, the plate of an oscillator tube would be bypassed to the chassis with a condenser of negligible reactance, however, in this case a very low impedance, common to both plates, is inserted between the plates and chassis. This impedance can consist of a non-reactive resistor having a value of from 300 to 500 ohms. A wirewound resistor should not be used.

The two frequencies across the "monoload" resistor, of substantially equal amplitudes, are applied to the grid of a plate-type rectifier consisting of a type 6AC7 tube operating with cathode bias to near cut-off. This tube operates as an adder, the plate tank being tuned to cover the frequency range of 3.5 to 4.0 megacycles. The tuning condenser is ganged with the tuning condenser of the 2.5 to 3.0 megacycle oscillator thus allowing single frequency control of the unit.

The ouput of the adder is applied through an anti-hash resistor of 1000 ohms to the grid of a cathode follower. A cathode follower will tend to develop hash when operating in cascade with a high gain rectifier due to a multivibrator action unless such oscillations are prevented. A 1000 ohm resistor, connected in series with the cathode follower grid, was found to prevent this effect. Without it the hash was present.

All components were of usual commercial grade except the coils which were wound according to data given in Table 1.



R—470 ohm, ½ w. res.
R_1, R_2, R_3—100,000 ohm, ½ w. res.
R_4, R_5, R_6—1000 ohm, ½ w. res.
R_7—300 ohm, ½ w. res.
R_8—10,000 ohm, ½ w. res.
R_9—30,000 ohm, 1 w. res.
R_{10}—10,000 ohm, 10 w. wirewound res.
C_1, C_{17}—25 μμfd. (ganged) air tuning cond.
C_2, C_{18} C_{19}—100 μμfd. air trimmer
C_3, C_4, C_5—200 μμfd. mica cond.
C_6, C_{14}—100 μμfd. mica cond.
C_7—.1 μfd., 400 v. cond.
C_8, C_{12}, C_{13}, C_{15}—.01 μfd. mica cond.
C_{11}—.005 μfd. mica cond.
C_{16}—.001 μfd. mica cond.
S_1*—Panel push-button sw.
J—Relay or key jack
L_1, L_2, L_3—See Table 1
RFC—2.5 mhy. choke
V_1**—6SN7GT tube
V_2**—6AC7 tube
V_3**—6J5GT tube
V_4**—0D3/VR150 tube
* When keying and monitor relays are turned "on" with the transmitter, this enables setting the v.f.o. to the same beat note as the received signal on the receiver prior to switching transmitter "on" at start of communication.
** One heater terminal of each tube is connected to the chassis.

Fig. 2. Circuit diagram of the v.f.o. An external power supply is required.

COIL	FREQUENCY	EN. WIRE	CATHODE TAP	GRID TAP	TOTAL TURNS
L_1	2.5-3 mc.	No. 26 B & S	10 t.	20 t.	48
L_2	3 mc.	No. 26 B & S	12 t.	24 t.	64
L_3	3.5-4 mc.	No. 26 B & S			24

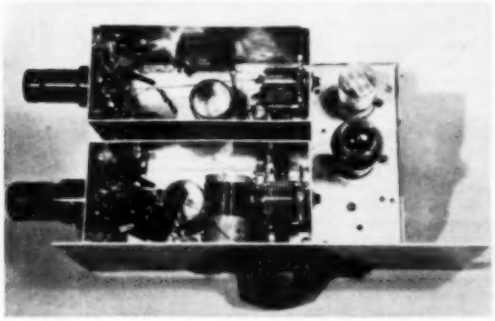
Table 1. Data for winding coils L_1, L_2, and L_3. See text for additional details.

All coils were wound with no spacing on compound tubing of good quality having an outside diameter of 1¼ inches. The "Q's" averaged about 130. The coils were fixed with *Amphenol* No. 912 Coil Dope. The values of "Q" are not restrictive. Coils having higher "Q" values may be used if desired. In the model the oscillator coils were mounted at right angles to each other in the same shielding compartment. The steatite socket for the 6SN7GT oscillator tube was offset on studs mounted on the side of the compartment shield so that the tube was outside the compartment and heat from it could not be transferred to the compartment. The tube was in a horizontal position for better heat radiation. No shield was used over the tube and the design was such as to allow no restriction of air circulation around the tube. The idea in back of this was to subject both coils to ambient temperature only with no added effects due to tube heat. Since this was done initially, the degree to which it assisted in maintaining constant frequency was not determined. It was considered to be advisable, however.

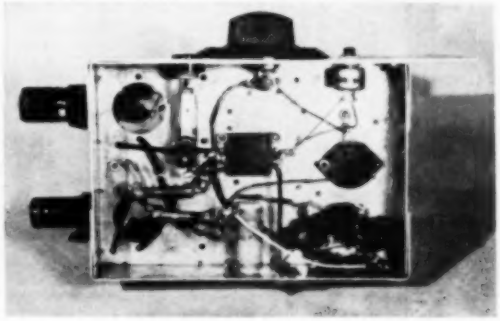
The individual oscillators can be aligned approximately by listening to them on a communications receiver. Adjusting a trimmer on either oscillator after this will permit setting the operating dial as desired. For the values given, the 3.5 to 4.0 megacycle band will be covered with a 180 degree

(*Continued on page 126*)

Top chassis view showing the special shielding compartments.



Under chassis view. Tubes are operated in horizontal position.



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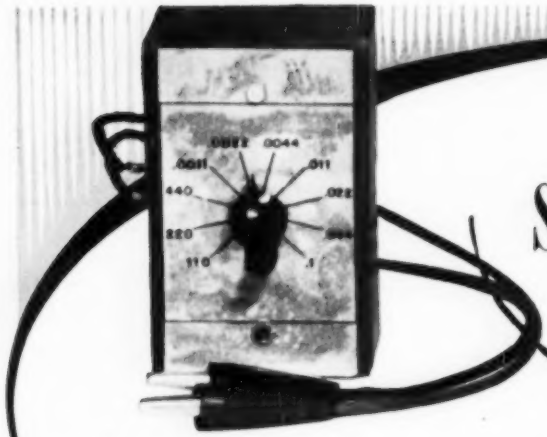


Fig. 1. A variable condenser box.

By WALTER H. BUCHSBAUM
Author, "Television Servicing"

AS TECHNICIANS become more proficient in their work, the tendency is to find shortcuts and time savers to increase the number of sets that can be repaired in a given length of time. The greatest time saver, of course, is a thorough understanding of TV circuitry and some simple logic. But there are many other tricks to speed up servicing. Probably the simplest is the use of clip leads. A rubber-covered black or red test lead with a covered alligator clip at each end can be a genuine time saver. By means of clip leads, suspected parts can be shorted out temporarily; other components can be connected into the circuit and switched around to different points while the set is in operation. A good example is the case of excessive 120 cycle hum in a TV set. To locate the defective filter condenser, connect the can of a good replacement condenser to the "B minus" bus in the receiver and the center terminal to the center of the suspected filter condenser in the set. If this is done with wire and soldering iron, the set must be turned off each time, but if insulated clip leads are used you can observe the results right on the screen. It is a simple matter to shift the "hot" clip lead to other "B plus" points in the set until the defective filter section is located. Shunting good resistors across suspected ones, grounding a.g.c. or bias voltages, or checking for open coils can all be done while the set is in operation by means of a simple set of clip leads.

Most technicians already use clip leads extensively and it is the purpose of this article to illustrate several other items designed to speed up and simplify TV servicing. Fig. 5 shows two potentiometers which can be used to good advantage in TV troubleshooting. For ease of connection, insulated clip leads are brought out from one end and from the center terminal of the control. The entire control is taped up and its maximum resistance value marked on the bottom for easy reference. The taped body prevents shorts and shocks when the control is connected in the chassis. A busy technician will find it worthwhile to have a set of such controls around, ranging from 2 megohms to a 5000 ohm potentiometer. In the lower ranges the potentiometer should be of the 2 or 5 watt type to permit its use on circuits carrying larger currents. The applications of these controls are too numerous to list here, but some of the most frequent uses deserve mention. Whenever a resistor is burned and its value is not known, clip a taped control in its place. If the resistor is larger than 1 watt try the lower ohm range control first. Set the control for maximum resistance, turn the set on, and wait for results. Adjust the control for best operation of the particular circuit, turn the set off, and read the correct resistance value of the control with an ohmmeter. Then solder a resistor coming closest to the ideal value into the circuit. Another use for these handy controls is to locate defects due to resistors being off-value or to verify the need for values other than those originally used. A typical case is in vertical sweep circuits where the series resistors in the hold and height control may be satisfactory for one particular tube, but do not quite meet specifications when a different tube is used. In many big picture tube conversions such problems come up and the controls shown in Fig. 5 are real time savers there. Just clip them into the circuit, turn the set on, and set the hold and height controls to a center position. Then adjust the clip-controls for proper height and hold. Measuring the resistance with an ohmmeter tells you at once what permanent resistors to use. Once a set of these clip-controls is made up you will find so many uses for them that you wonder how you ever managed without them.

An item similar in its use to the clip-controls, is shown in the photograph of Fig. 1. This is a very inexpensive, home-built condenser box. Far from being an exact laboratory instrument, this little box covers the most frequently used condenser values from 110 $\mu\mu$fd. to .1 μfd. in ten steps. It is possible to make up a much more elaborate condenser box and cover a greater number of values, but for everyday service work we have found the type shown in Figs. 1 and 2 to be adequate. The principal use for this condenser box is probably in custom installations, big picture tube conversions, and similar work where you cannot be sure which condenser value will do the best job. In many cases where inadequate width and high voltage are observed, the coupling condenser to the grid of the horizontal output amplifier may have insufficient capacity. Connecting the condenser box into the circuit will quickly show the value needed for best results. In video peaking networks, tone control circuits, or de-emphasis filters the use of the condenser box permits quick selection of proper values under operating conditions.

Fig. 2 shows the circuit of this condenser box. A ten-position, double-deck, rotary switch was used here and the seven condensers are arranged in such a manner that they combine in series and parallel connections to give the values shown in Fig. 1. If you want to make a more elaborate device out of this condenser box, add more positions on the switch, another deck, or else a separate range switch to get the intermediate values missing in our present simple design. The author found the condenser box shown here adequate to give an indication in all cases where doubt existed as to what value condenser should be used in a particular circuit.

It should be understood that this condenser box is not usable at i.f. or r.f. frequencies, nor will it show exact values in resonant circuits such as are used in horizontal oscillator circuits. The distributed capacity and the relatively long leads make it unsuitable for anything above about 10 mc. It can be used to check the operation of bypass and decoupling condensers in AM and FM sets, r.f. high voltage power supplies, video and sound amplifiers, etc. It is especially useful in conjunction with the clip controls described previously when working out *RC* time constants for discharge networks, multivibrators, feedback circuits, and similar applications where the value of the condenser and resistor are dependent on each other and only one set of values gives optimum performance.

The condenser box is not suitable for r.f. and i.f. circuits above 10 mc., but the unit shown at the right in Fig. 4 is used for just such work. We took a $\frac{3}{8}$-inch polystyrene rod and cut a slot into one end into which was inserted a .005 mfd. ceramic disc type condenser. This simple gadget permits us to put this condenser into the circuit as a shunt for any r.f. or i.f. bypass condenser which might be open. It is not possible to hold this little condenser with the fingers since the hand capacity will detune the resonant circuits in the i.f. or r.f. section and thus give a false indication of the trouble. A good example of the application of this condenser holder is the case of an oscillating video i.f. section. Whenever the hand is brought near, the oscillation stops, but since the hand cannot be installed with the set, the defective part must be located. After checking the alignment with a bias battery to cut out the oscillation, the conclusion is that a defective bypass or decoupling condenser is causing the oscillation.

Touching the .005 mfd. bypass condenser across each of the bypass condensers in the i.f. section will eventually locate the defective one by stopping the oscillation. Ordinarily you might have unsoldered several bypass condensers, checked them or replaced them before locating the defective one. By using the condenser holder the defect is located in just a few minutes.

In order to increase the efficiency of this little gadget we turned the other end down to about $\frac{1}{4}$-inch diameter and cut another slot there. This can either be used to hold another, smaller value condenser or else to twist and poke wires and connections in the search for intermittent or cold solder joints.

The Z-shaped item on the left of Fig. 4 is also used mainly in the r.f. and i.f. stages. The handle and main piece is a $\frac{1}{4}$-inch polystyrene rod, having a tuning slug on each end. One of the slugs is a powdered iron core from a discarded i.f. coil, the other is a copper slug salvaged from an old TV booster. The brass studs of each tuning slug were heated with a soldering iron and then forced into a smaller diameter hole in the polystyrene. Polystyrene softens under the heat, but regains its firmness as soon as it cools off. To permit easier insertion of the tuning slugs into the coil forms, round off the edges with sandpaper. Instead of the copper tuning slug a $\frac{1}{4}$-inch round solid copper or brass rod can be used.

The tuning stick described can be used to great advantage in checking the alignment of r.f. or i.f. sections. Set an AM signal generator to the correct i.f. frequency of a particular coil and connect a v.t.v.m. across the second detector load resistor. Now insert the powdered iron core into the coil. If the meter reading decreases, the coil does not need additional inductance. Next insert the copper core. If the meter dips again the coil is tuned to the correct frequency. If the reading on the v.t.v.m. increases when the copper core is inserted, the inductance should be reduced. If the meter reading increases as the powdered iron slug is inserted, more inductance is required.

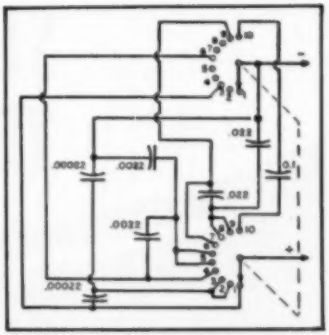


Fig. 2. A simple variable condenser box.

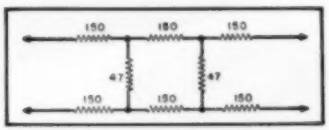


Fig. 3. Circuit of a 35 db attenuator.

In checking the performance of boosters and r.f. tuners this is particularly handy. There the adjustment can be done with a picture on the screen and the coils can be tuned for best picture and sound. Many r.f. tuners and boosters use fixed coils made of heavy copper wire. To increase or decrease the inductance squeeze or spread the turns as the tuning stick may indicate. When in doubt as to the operation of any coil, insert both slugs of the tuning stick and check for a reaction. If no change is observed, the circuit may be inoperative.

A type of construction which may be used for the tuning wand is a piece of large diameter spaghetti tubing with the slugs inserted in the ends.

The last item on our list of simple service aids is the attenuator pad

(*Continued on page* 94)

Fig. 4. Tuning stick and condenser holder.

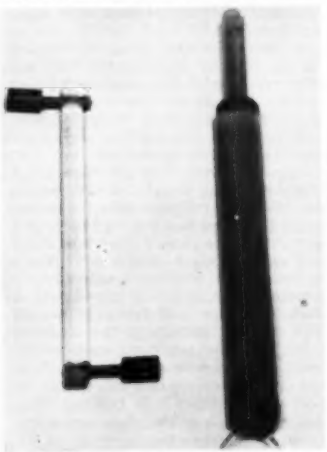
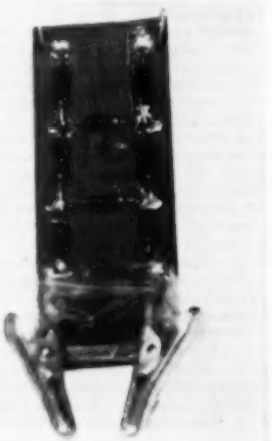


Fig. 5. Clip leads for parts substitution.

Fig. 6. Simple r.f. attenuator for TV work.



SLIDE TUNING THE 75-METER LOADING COIL

The number of turns in the coil may be readily adjusted by means of the sliding clip to permit antenna to be tuned to exact resonance.

Methods of adjusting the electrical length of a whip antenna to provide greater field strength.

By

JACK NAJORK, W2HNB

NEARLY everyone who has tried mobile operation on 75 meters becomes a fanatic on the subject of antennas. Being no exception, the author digested most of the current literature on the topic and then started on a series of coil winding and whip hacking experiments that, to date, have ended up with the version to be described. Hams being what they are, it is doubtful that the "ideal" goal will ever be reached—however, the present design comes close to meeting all the major requirements and has proven itself in over five thousand miles of driving.

Initial tests showed that a quarter-wave, center-loaded whip was capable of excellent performance—provided it was correctly tuned and loaded. The final search thus narrowed down to a reliable and foolproof system of tuning this type of antenna. This is not nearly as simple as it sounds when one considers the requirements or, more specifically, our requirements. Electrically, the system should have high efficiency; be continuously tunable across the entire band; and finally, it should be capable of quick and accurate reset. In short, we wanted an antenna that we could hop out and retune during a traffic light change.

Mechanically, the antenna should be rugged enough to slap tree branches and underpasses at 50 mph without disintegrating; it should have low wind resistance, and it shouldn't make the XLY too unhappy from an aesthetic viewpoint.

Because of the very high "*Q*" of a short, electrically-loaded whip, the antenna must be critically tuned to the operating frequency if it is to take power and do a good job of radiating. Tuning is accomplished in this design by a loading coil whose inductance can be varied in one turn steps by means of a sliding clip arrangement.

Anyone who has probed an energized, center-loaded whip with a neon bulb soon learns that the loading coil is really "loaded" with r.f. Although there are "pros" and "cons" as to whether the coil does most of the radiating, we decided to get it up in the air high enough to clear the top of our *Studebaker* and thus give that r.f. a chance to go places if it had a mind to. However, a coil that high in the air stops a lot of breeze at high speeds and after picking up the remains of an earlier model, we learned that the wind resistance has to be low and the coil weight has to be small. So it appears a compromise is in order. You can either use a large, very high "*Q*" coil near the base of the antenna, or you can sacrifice some "*Q*" with a smaller coil and stick it up high.

As shown in the photograph, our version has the coil positioned about four feet above the base of the antenna. The coil is topped with a seven foot whip section for an over-all antenna height of slightly more than eleven feet. Many hams, seeing this antenna for the first time, look up and gasp at the height. However, our antenna is still in one piece after five thousand miles of highway and city driving so we consider this height entirely practical. Of course if you do most of your driving on streets lined with low tree branches you may want to reduce the height somewhat. This will lower the radiation efficiency of the system somewhat but we're not at all sure that the station at the other end will notice the difference on his "S" meter.

The loading coil is wound on a piece of polystyrene rod one and five eighths inches in diameter and four inches long. Although it is not essential that poly be used, its heat-softening characteristics make it ideal in this application, as will be seen later. The coil is constructed in two sections. The top half, which is contacted by the sliding clip, is spacewound with 33 turns of #22 tinned, bare wire, while the bottom half is wound with 33 turns of #24 plastic insulated wire. The smaller wire size is used on the lower half in order to obtain the necessary inductance on the comparatively small coil form used.

A very neat job of space winding can be done by securing the wire and a length of twine to a support and then rolling the coil form in the hands so that the twine falls between wire turns. When this section of the coil has been wound, anchor the last turn to the form by pressing it with a hot, clean soldering iron. Do not remove the twine—yet! Next, take the soldering iron and anchor the wire to the coil form on either side of a vertical channel about half an inch wide. This is the portion of the top winding that is contacted by the sliding clip so be sure that each turn is individually pressed into the coil form with the soldering iron. These turns must be secure on both sides of the channel, otherwise the pressure of the clip will spread the wire and contact will become intermittent. Follow the same procedure on at least two other sections of the

winding on the upper length of the coil so that all the bare turns are permanently locked in place. Now remove the twine and wipe the coil lightly with a rag moistened with carbon tet. This method of securing the wire to the coil form is superior to cementing and is just about a necessity in this design unless a grooved coil form is used.

The coil is completed by splicing on and winding the insulated wire on the bottom half of the form.

Our coil had a measured inductance of 92 microhenrys and a "Q" of 240. It resonates with the eleven foot antenna at 3800 kc. with four turns shorted out. However, don't make the mistake of pruning your system to these exact specifications in the hopes of duplicating these conditions because the body contours of your car and the location of the antenna will affect the resonant frequency considerably. The most practical precedure is to wind the bottom of the coil full of wire and then peel off turns one at a time until the system resonates at the low end of the band with one or two turns shorted out by the clip. We allowed some spare inductance so that the antenna could be tuned down into the c.w. portion of the band but this is a personal choice that does not have to be duplicated.

The ends of the coil windings are brought to suitable fittings at the top and bottom of the coil, and these can be anything you can dig out of the junk box. We used a microphone connector collar bolted to the lower end with a ¼"-20 bolt so that the coil and upper whip section can be demounted without the use of tools. A ¼" brass rod was heat-fitted into the upper end of the coil body. The appropriate mating fittings are press-fitted into the whip sections and then soldered. The whip itself is a surplus 12' section of the type that screws together.

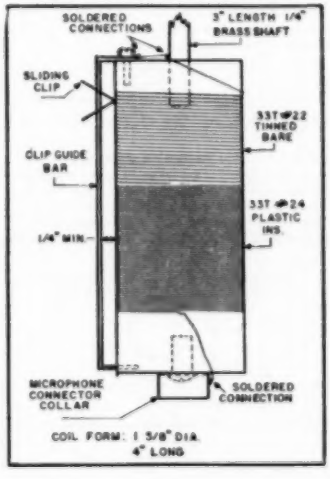
A piece of #14 phosphor bronze wire is used for the vertical clip guide bar. It is secured to the top of the form by a small, self-tapping screw, and a soldered connection is made from this point to the whip fitting. The clip is made from a small piece of phosphor bronze spring, bent and drilled as shown in the photographs. With the clip on the guide, the bottom end of the guide is secured to the bottom side of the coil form by pressing it directly into the body with a hot soldering iron. Don't use a self-tapping screw at this spot! We did, on the first model, and discovered that the several thousand volt potential between this point and the bottom turns of the coil resulted in an arc right through one eighth inch of the coil body. Because of this potential, the vertical clip guide bar should be spaced at least a quarter of an inch away from the bottom turns of the coil, otherwise you'll have some unexpected fireworks! Adjust the tension on the sliding clip by bending the upper part of the guide bar so that the clip fits snugly in place between adjacent turns.

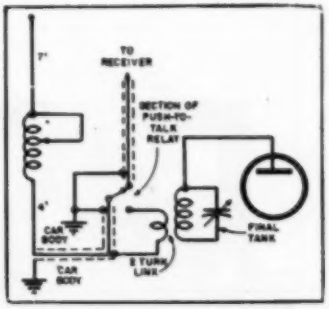
The antenna is mounted on the car with a ball-joint fitting but a base spring is not used. Unless you can find an unusually stiff spring, it is best to use none at all because whipping of the antenna, (or more specifically, back-swaying at high speeds) changes the capacity between the antenna and the car body enough to almost completely detune the system. Without the spring, the top of the antenna sways slightly but there is no detuning.

Low impedance coaxial cable is used to feed the antenna at its base. In our case, a twelve-foot section is run to the dash where the transmitter is located. The outer braid is grounded to the car body at both ends. A two-turn link, wound over the cold end of the final amplifier tank circuit, is used to couple the transmitter to the coax.

Tuning should be done in a location at least ten feet from trees, buildings, etc. Dip the final amplifier tank circuit to resonance with the coax disconnected at the transmitter end. Then connect the coax to the transmitter and adjust the clip on the loading coil until the final amplifier plate current rises. The effects of your body will completely detune the system, so you have to make an adjustment and then step back four or five feet and observe the effect on the plate current meter. It should be possible to pass through a plate current peak by sliding the clip one turn at a time (with power off the transmitter during the sliding) and the correct setting is the one that produces maximum plate current. When this setting has been reached, redip the final to tune out the reactance of the feed cable. If the coil tap is correct, only a very slight readjustment should be necessary. A large readjustment indicates that the position of the clip is incorrect, and in this case, loosen the coupling to the final amplifier tank and repeat the procedure. In most cases it will be found that the amount of

Mechanical details of the coil construction. It is important that the construction be as rigid as possible for mechanical strength.





Coupling and antenna switching connections.

coupling used with the transmitter on the conventional half-wave home antenna will be much too great when the center-loaded whip is used because of the much higher "Q" of the latter system. If insufficient loading is encountered it can be corrected by increasing the link turns or by increasing the "C" and reducing the "L" of the final amplifier tank circuit.

If several crystals are available in widely separated sections of the band, the clip settings for each frequency can be marked on the coil with a dot of colored nail polish (*i.e.*, "flamingo red" for 3817 and "purple passion" for 3910). With an eleven foot antenna, it is possible to QSY about fifteen kilocycles off the center frequency to which the system is originally tuned without causing the loading to drop off more than twenty per-cent.

The coil is waterproofed by cementing on a double layer of polyethelene "skin." This material is widely used in grocery stores to package apples, potatoes, etc., and is also marketed in five and dime stores for use as refrigerator storage bags. The vertical channel contacted by the sliding clip is, of course, left uncovered, but the remainder of the coil is entirely sealed. It is not necessary or desirable to apply cement to the entire coil for this operation. Cut the covering to size and then cement it only at the top, bottom, and cut-out portions of the coil. After this has dried, go over the joints at the top, bottom and cut-out sections of the coil with more cement to make sure that everything is sealed up tightly.

Results? 120 mobile QSO's to date, practically all non-scheduled, with W1, 2, 3, 4, 8, VE2 and VE3 during daytime driving in central New York State. Many of these stations were 100 to 300 miles away and the majority of them were raised by calling CQ. The transmitter runs 25 to 30 watts input to a 6L6, modulated by another 6L6.

Although the coil described was designed for 75 meters, there appears to be no reason why this type of construction cannot be used for a coil which can be resonated to the higher frequency bands as well. Right now, we're sold on 75, and we're trying to dope out a way to slide that clip without leaving the driver's seat. Any ideas?

-30-

AUDIO Simplified

By
DAVID FIDELMAN

Rack mounting frame containing two pre amplifiers and one voltage amplifier of the type described in the schematic of Fig. 8.

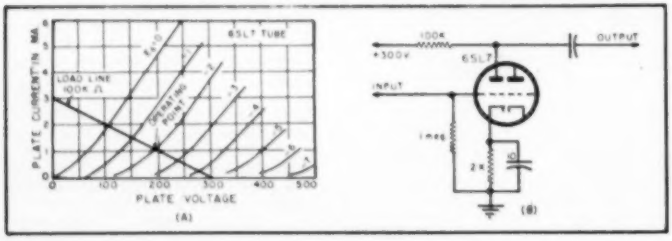
Part 5. How plate characteristics and load lines are used in designing audio amplifier circuits.

IN ANY audio reproducing system, after the electrical signal from the microphone or pickup has been raised in level by use of a low-noise preamplifier, it must then be further amplified by a fairly high-gain voltage amplifier. This additional amplification serves two functions: (a) it increases the signal to the voltage necessary to obtain full power output from the power amplifier through the driver amplifier, or for further mixing, equalization, transmission over telephone lines, etc.; and (b) it makes up for any insertion loss introduced by the use of any mixing, equalization, or transmission units in the sound reproducing system.

The reproducing system may be set up in a number of different ways, according to the specific requirements of the individual application. Mixing or equalization may take place ahead of the voltage amplifier directly after the preamplifier (or even in the preamplifier unit), or after one section of the voltage amplifier. In either case, the input signal to the voltage amplifier is at a higher level than the input signal to the preamplifier, therefore the introduction of noise in the voltage amplifier is not the major factor that it is in the preamplifier. In the voltage amplifier, the major requirement is high gain without distortion or instability.

The voltage amplifier consists essentially of a number of amplifier stages whose total gain and output voltage meet the system requirements. The individual amplifier stages may be either triodes or pentodes—the choice depending upon both the requirements of the circuit and the individual preference of the designer (since there is still considerable discussion concerning the relative merits of triodes and pentodes). The procedure followed in the design of the amplifier is to start from the knowledge of the input and output voltages, the required input impedance, and the impedance of the load which the output of the amplifier sees. Then the various amplifier stages and impedance-matching circuits are designed for the required voltage gain and impedance.

Fig. 1. Use of plate current characteristics and load line to design amplifier stage. (A) Plate current characteristics of a typical triode tube, showing curves of plate current against plate voltage for different constant grid voltages. Also incorporated on the graph is a load line representing voltage at plate of any tube connected to 300 volt "B" supply through a 100,000 ohm resistor. (B) An amplifier stage designed from the curves of (A).



Voltage Amplifier Stage

The most important single component of any complete amplifier is the single vacuum-tube amplifier stage (since the amplifier is essentially a combination of single stages), and the correct design and operation of each stage is necessary for proper operation of the system. For any experimenting in sound and audio reproduction, it is essential for the experimenter to understand the basic operation and the fundamental principles of design of amplifiers, so that he can better understand the circuits with which he is working. He can then design more intelligently in construction of equipment, and will find it much easier to troubleshoot more intelligently and quickly in case of circuit failure. The design of the amplifier is done graphically by use of the curves of tube operation published by the tube manufacturer, and does not require the use of complicated mathematical formulas or extensive calculation.

The use of these curves in the design makes it possible to predict in advance what the performance will be, without the necessity of first building the circuit in order to find out whether it meets the requirements. The most important curves of vacuum tube operation are called the *plate characteristics*, which consist of a number of curves in which the plate current is plotted against the plate voltage, each curve being for a different constant grid-cathode voltage. These are the tube characteristic curves which are most

generally given by the manufacturers in the tube manuals, and are most often used in the amplifier design procedure. The plate characteristics of a typical widely used triode (one section of the type 6SL7 dual triode taken from the *RCA* tube manual) are shown in the diagram of Fig. 1A. These curves show the variation of plate current with plate voltage, for different constant values of grid voltage from 0 to −7 volts. The various tube factors (plate resistance, amplification factor, etc.) are determined from these curves.

In a graph of current plotted against voltage, consider the straight line which is drawn as shown in Fig. 1A. This line represents a resistance in series with the plate of the tube, and the line will be the same regardless of what tube characteristics are drawn on the same graph. Any point on this line shows the voltage from plate-to-ground for the particular current which is indicated. For example, when the tube draws no current the full supply voltage is on the plate since no voltage is developed across the resistor, and when the entire voltage is developed across the resistor then the voltage from plate-to-ground is zero. This line is known as the *load line*, since it represents the plate voltage of the tube for this specific value of load resistance.

If a load line is drawn over a set of plate characteristics of a specific tube, the resulting curves will give the operating characteristics of the tube for the particular power supply voltage and plate resistance which have been selected. Consider, for example, the set of plate characteristics and the load line which are drawn together in the graph of Fig. 1A. These particular curves represent a typical triode amplifier stage and practical circuit values which are widely used in audio amplifier design. The tube characteristics are those of Fig. 1A, and the load line represents a 100,000 ohm plate resistance for a "B+" voltage of 300 volts d.c. The load line is drawn by knowing the two facts that (*a*) when there is no current the voltage from plate-to-ground is 300 volts, (*b*) when the voltage from plate-to-ground is zero the voltage across the resistor is 300 volts, resulting in a current of 3 ma. through the resistor, and by connecting these two points with a straight line. All the points along this line then show the operation of the tube under these conditions. For example, if the grid voltage of the tube is selected as −2 volts, then the current through the tube is given by the intersection of the load line with the −2 volt plate current line, showing that the current is approximately 1 ma. and the voltage from plate-to-ground is approximately 200 volts.

This information can be used to design the amplifier stage shown in Fig. 1B. The grid-cathode bias voltage is obtained by means of a bypassed 2000 ohm resistor between cathode and ground. The effect upon the plate circuit of a signal voltage applied to the grid can be seen by taking the different points along the load line and observing the plate voltages and currents. Thus, a peak grid swing of +1 volt to −1 volt will cause the grid-cathode voltage to swing between −1 and −3 volts, and the voltage at the plate will swing from 155 to 245 volts — which is 45 times the grid signal voltage.

Equivalent Plate Circuit

The circuit of Fig. 1B can also be redrawn in another way which makes it possible to predict the frequency response and output impedance of the amplifier stage without the necessity of building the circuit in order to measure it. This method of redrawing the tube circuit is shown in Fig. 4A, drawn to also include the grid input circuit of the following tube. The amplifier circuit has the same characteristics for the a.c. signal as if the voltage $-\mu e_g$ were applied in series through a resistor equal to the plate resistance of the tube to the load circuit, which consists of the plate load resistor to ground and through the coupling condenser to the grid and grid resistor of the next stage. Also in the circuit are the plate-cathode capacity and the plate circuit wiring capacity, and the next tube input capacity and the grid circuit wiring capacity to ground. The circuit of Fig. 4A is called the *equivalent plate circuit* of the amplifier.

The manner in which the equivalent plate circuit can be used to predict the amplifier performance can be seen from the three circuits shown in Fig. 4B, which are derived from the circuit of Fig. 4A. These circuits show the components which are important at

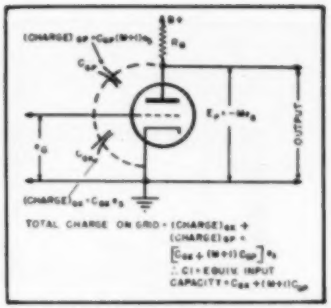


Fig. 2. Miller effect increase in input capacity due to amplification of the tube with the resistive plate load.

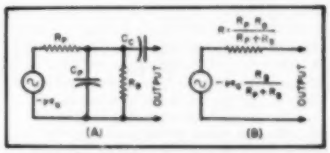
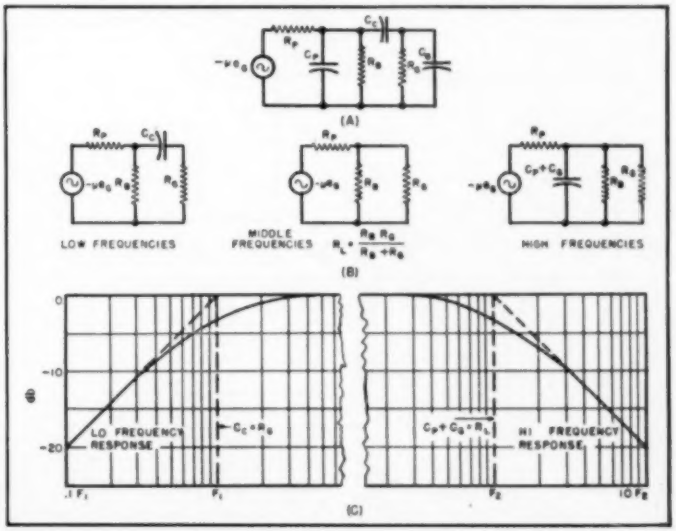


Fig. 3. Method of determining the output impedance of an amplifier. (A) Equivalent plate output circuit of the amplifier shown in Fig. 2. (B) The effective output circuit at the middle frequencies.

the low, the middle, and the high frequencies. At middle frequencies the series coupling condenser can be replaced by a short circuit and the shunt condensers by open circuits, leaving only the resistances in the circuit. The gain is then determined by the voltage divider composed of the R_g and R_L parallel combination in series with R_p. If the resistance of R_g in parallel with

Fig. 4. (A) Equivalent plate circuit of the amplifier stage shown in Fig. 1B, including the grid input circuit of the following tube. (B) Simplified forms of circuit of (A) which are accurate at low, middle, and high frequencies. (C) Frequency response at low and high frequencies due to shunt and coupling capacities.



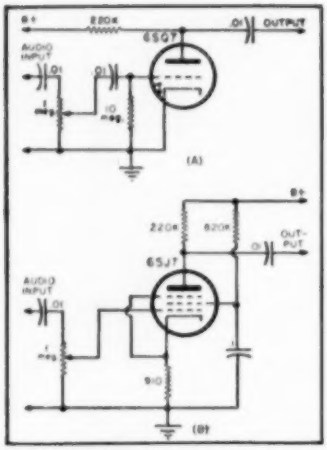


Fig. 5. (A) Typical high gain triode amplifier. (B) Pentode amplifier which can be used in place of the triode in (A) to provide an improved frequency response.

R_s is calculated and called R_l, then the gain of the stage from grid input signal to signal applied to the next grid is equal to $-\mu e_s R_l/(R_s + R_l)$. This value is negative, because the signal in the plate circuit of a vacuum tube is opposite in phase to the grid input signal.

At low frequencies, the impedance of the coupling condenser must be considered in series with the following grid resistor. This impedance determines the low-frequency response of the amplifier circuit, since it forms one arm of a voltage divider whose output decreases as the condenser impedance increases from lower frequencies. The response is 3 db down at the frequency where the impedance of the coupling condenser is equal to the grid resistor, and approaches a falling off of 6 db for every octave below this frequency.

At high frequencies the shunt capacities must be considered. The shunting capacity is the total capacity to ground on both the plate and grid sides of the coupling condenser. This capacity determines the high-frequency response of the amplifier stage since it is in parallel with the shunt arm of the plate resistance/load resistance voltage divider and causes the output voltage to decrease as the capacitive impedance decreases for higher frequencies. The response is 3 db down at the frequency where the impedance of the total shunt capacity is equal to the combined resistance R_l, and approaches a falling off of 6 db for every octave above this frequency.

The effects of these capacities account for the frequency range limitations of resistance-coupled voltage amplifiers. The resulting frequency response due to these effects is of the type shown in Fig. 4C.

Miller Effect

An extremely important factor which imposes certain limitations on the practical design and choice of tubes in audio amplifiers is the *Miller effect*. In the equivalent circuit of the amplifier, shown in Fig. 4B, it can be seen how the capacity in the grid circuit of the following stage affects the response at high frequencies. Thus, if the input capacity of the following stage is high, the effect on the high-frequency response may be considerable. This input capacity is not a constant of the tube and is different when there is a load in the plate circuit than when there is no load. This effect is known as the *Miller effect*. When there is a resistive load in the plate circuit of a tube, as shown in Fig. 2, the voltage on the plate is $-M$ times the voltage on the grid (M being the amplification of the stage). The total charge on the grid due to the grid-plate capacitance and the potential difference due to the gain of the tube acts as if the capacity were $(M + 1)C_{gp}$. Therefore the tube has an input capacity of:

$$C_i = C_{ck} + (M + 1)C_{gp}$$

In high gain triodes this effect is quite large, whereas the Miller effect is negligible for pentodes because they have such a low grid-plate capacity.

As an example of the importance of the Miller effect, consider one section of a 6SL7 as a voltage amplifier.

$C_{ck} = 3.4$ $\mu\mu$fd.; $C_{gp} = 3.2$ $\mu\mu$fd.

$M = 41$

$C_i = 3.4 + (41 + 1)3.2 = 137.8$ $\mu\mu$fd.

which is 21 times the input capacity of 6.6 $\mu\mu$fd. with no load in the plate circuit. This is quite a high capacity, and if this input capacity is located in a high-impedance circuit (such as the plate circuit of a pentode amplifier stage, or a 1 megohm volume control), it will cause a serious loss of high frequencies. In the worst cases, this high frequency loss cannot even be compensated by equalization. For example, in a 1 megohm volume control the attenuation at 10,000 cps may vary between 0 and 10 db, depending upon the volume control setting, and no one equalization curve will effectively compensate for all volume control settings. The only practical method of eliminating the problems of the Miller effect is to avoid the use of high gain triode stages in high impedance circuits whenever good high frequency response is desired, and to design the circuit and choose tube types with this limitation in mind.

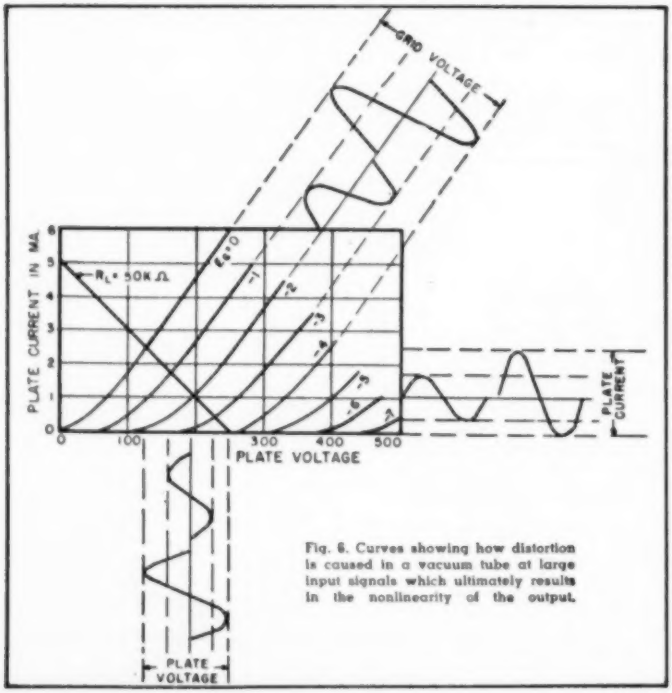


Fig. 6. Curves showing how distortion is caused in a vacuum tube at large input signals which ultimately results in the nonlinearity of the output.

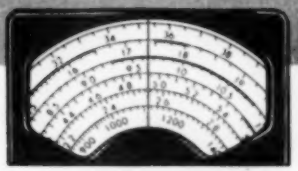
Design Procedures

From the information contained in the plate characteristic curves and the equivalent circuit of the amplifier stage, its performance can be quite accurately predicted. The actual details and arithmetic of these procedures, that is, the basic practical steps in selecting the circuit values for an amplifier design, together with a brief summary of the most essential points which have been described in the previous sections of this article, are presented in the following few paragraphs:

(a) *Gain* of the stage is determined

(*Continued on page* 136)

International SHORT-WAVE



***Compiled by* KENNETH R. BOORD**

IT IS a pleasure this month to dedicate the *ISW DEPARTMENT* to radio in Japan. Our thanks go to Hal Stein, San Francisco, and to Isamu Yamazaki, chief of the International Broadcasting Section, Nippon Hoso Kyokai (Broadcasting Corporation of Japan), Tokyo, for this interesting data.

Mr. Yamazaki airmails that "our short-wave transmissions are made at present for two purposes—one is for the benefit of Japanese nationals in the Far East awaiting their repatriation to Japan (Far Eastern Service) and the other is for transmission to various key stations in Japan of the same programs sent on the air by NHK in Tokyo. All short-wave transmissions are radiated from the stations at Nazaki, Yamata, and Kawachi which belong to the Telecommunications Ministry.

A recent Associated Press dispatch from Tokyo announced that the Japanese Government will shortly resume overseas broadcasts of news, commentary, and music, beamed to North America, China, the Philippines, Indonesia and India. The transmissions are to be five hours a day in English and Japanese.

Current schedules sent by Mr. Yamazaki are—First transmission relay and communication for Domestic Service, JKH, 7.2575, Yamata, 5 kw., 1530-0900; JKI, 4.910, Nazaki, 5 kw., 1530-1715 and 0255-0900; JKI-2, Nazaki, 9.655, 5 kw., 1725-0245.

Second transmission relay for Domestic Service, JKJ, 7.285, Nazaki, 5 kw., 1530-0900; JKM, 4.940, Kawachi, 5 kw., 1530-1715 and 0310-0900; JKM-2, 9.695, Kawachi, 5 kw., 1725-0300.

Far Eastern Service, JBD, 9.505, Kawachi, 7.5 kw., 1530-0505 and 0255-1000; JBD-2, 9.560, Kawachi, 5 kw., 0255-1000; JBD-3, 15.225, Kawachi, 7.5 kw., 1915-0245; JBD-4, 15.235, Kawachi, 5 kw., 2200-0245, and JKI-4, 11.800, Kawachi, 5 kw., 1530-2145.

All communications should be addressed to International Broadcasting Section, Nippon Hoso Kyokai, Radio Tokyo Building, Tokyo, Japan.

NHK has 8 regional stations, 38 local stations, and 31 rebroadcast stations, covering 9,250,194 registered listening households as of June 1, 1951. Since an average of 4.5 listeners utilize radio in one household—according to a survey—approximately 55.8 per-cent of the Japanese nation has been served by NHK. Except for rebroadcast stations and a few local stations, each station transmits two different network programs; the major part is provided by Tokyo, interrupted by local and regional broadcasts.

In March 1951, NHK observed its 26th birthday. Tetsuro Furukaki, president of NHK, says: "Since the termination of war, the Japanese radio has worked itself more and more into the life pattern of the people, and today it has become, for good or for evil, an indispensable part of our national life. . . . Our motto in the NHK is 'Radio Links Us With the World.' This is the sentiment that symbolizes what we do, for we feel that radio can be a powerful influence in establishing world peace and international brotherhood."

NHK officials point out that with the termination of the war, Japan made a new start on the road towards the establishment of a democratic nation. And that since governmental control on radio was lifted, NHK drew up new Articles of Corporation and began to put forth efforts towards improving and expanding its facilities with the idea of establishing a free and independent radio enterprise and of becoming truly a people's radio. In view of the importance of the radio in the construction of a democratic and peaceful nation, the Broadcast Law, designed to bring the radio in line with the welfare of the public, was passed in 1950 and enforced. The present NHK, based on this Law, succeeded to all the facilities and staff of the former Broadcasting Corporation of Japan. "It is now prerequisite for NHK to consider itself operated by the concerted will of the general public and to conduct broadcasts that are acceptable to the people."

A Japanese radio official summarizes like this:

"NHK's broadcasts can be heard all over Japan—in the hills, in the fields, in the cities and towns, and in the remote villages. The radio brings people together to enjoy collective listening. The radio brings peace among the people. And the world culture is being diffused among the Japanese people through the radio. For the people, the day starts out with the radio and ends with the radio. The radio brings happiness and joy to the people. And that is connected with the path towards the construction of a peaceful Japan and, in a larger sense, towards the establishment of world peace."

Our best wishes go to the Broadcasting Corporation of Japan and all its personnel in their efforts to expand and strengthen the services of NHK!

* * *

New WRH Available

North American SWL's will be interested to learn that the *new* (1951-52) edition of *World Radio Handbook*, compiled by O. Lund-Johansen, Copenhagen, Denmark, is now available for $1.50 postpaid from Ben E. Wilbur at his *new* QRA—1000 Connecticut Avenue, N. W., Washington 6, D. C. *WRH* is in *English*.

* * *

This Month's Schedules

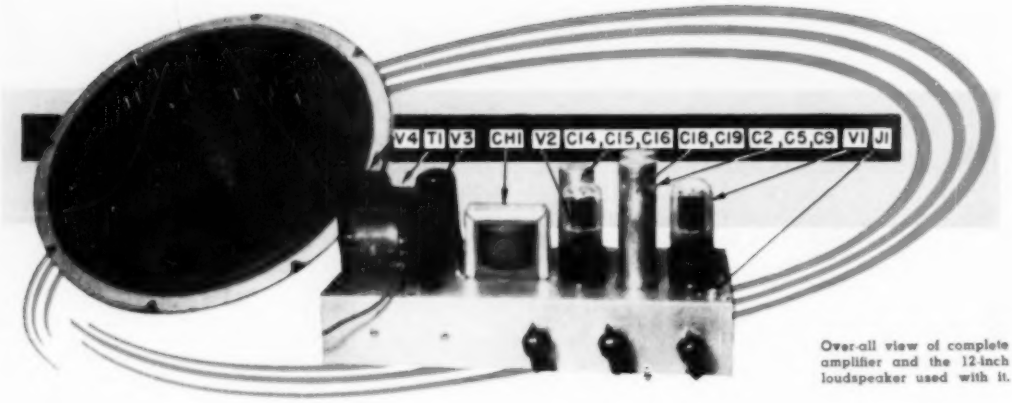
Afghanistan — Radio Kabul, 9.975, noted weekdays to 1150; Sundays to

(*Continued on page* 118)

The Radio Tokyo (NHK) building in Tokyo. It is a six-story building with studios, control rooms, office rooms, etc. Programs presented in the studios are carried by land lines to the transmitting station. Plans are underway for construction of another building at the rear of this one to provide enlarged broadcasting facilities.

(Note: Unless otherwise indicated, all time is expressed in American EST; add 5 hours for GCT. "News" refers to newscasts in the English language. In order to avoid confusion, the 24 hour clock has been used in designating the times of broadcasts. The hours from midnight until noon are shown as 0000 to 1200 while from 1 p.m. to midnight are shown as 1300 to 2400.)

The symbol "V" following a listed frequency indicates "varying." The station may operate either above or below the frequency given. "A" means frequency is approximate.



Over-all view of complete amplifier and the 12-inch loudspeaker used with it.

A Compact High-Gain AMPLIFIER

A low-cost and compact unit which has provision for both phono and microphone-tape head inputs.

By
LLOYD B. BUST

THE design possibilities of audio equipment are practically limitless with the wide variety of tubes and other components which the builder has at his disposal at the present time. Good audio equipment may range all the way from the small ultra-compact amplifiers used in modern hearing aids to the multi-watt jobs used for public address work for large outdoor gatherings. In fact, this might be termed the age of specialization as far as audio equipment is concerned. No longer is it necessary to rely upon one all-purpose amplifier for one's needs. The up-to-date sound shop will have several types of amplifiers available for many different types of service. One type will be suitable for large outdoor coverage, another will be suited for auditorium service where pickup from several microphones may be necessary, while still another type may be required for the recording studio. The serious experimenter may wish to specialize, to some extent, adapting his audio equipment to his specific need. If one takes into consideration his requirements for a particular type of amplifier, its design and construction need be neither difficult nor expensive.

The amplifier to be described here is a good example. The author needed a small, inexpensive, high-gain amplifier for microphone reproduction, the playing of phonograph records, and the playing of tape recordings. Because compactness was necessary and because the design of the associated playback equipment made it necessary for the amplifier to be mounted very near to the phono pickups and tape playback head, it was decided that the conventional power transformer be eliminated from the amplifier. The mounting arrangements were such that if a power transformer were used, hum pickup would be intolerable.

The elimination of the power transformer introduced two other problems, however. One was the lower power output that could be expected if the output tubes were operated at line voltage. The other was the problem introduced by the difficulty of filtering the half-wave output of a rectified line voltage with its associated 60 cycle ripple, as compared with the ease of filtering the 120 cycle ripple from the output of a full-wave rectifier such as would be used with a power transformer.

The problem of lower power output was solved quite satisfactorily by using a voltage doubler circuit in which two 150 milliampere selenium rectifiers were used. The fact that filter condensers of relatively high capacitance were used also helped to solve the second problem. Theoretically, the use of a voltage doubler circuit will provide direct current at a voltage nearly double that of the line. However, load conditions modify, to some extent, this voltage rating. Measurement with a vacuum tube voltmeter showed the voltage at the input to the filter to be 210 volts. At the plates of the output tubes, 190 volts was measured. The line voltage at time of measurement was approximately 120 volts. These were full-load measurements.

In connection with the power supply it should be noted that resistors R_{20} and R_{21} are used to prevent damage to the rectifiers and associated equipment due to line surges with the resultant high peak voltages encountered. The use of these resistors does not materially decrease the usable voltage obtainable from the voltage doubler circuit. Also, it should be kept in mind that condenser C_{18} is not essentially a filter condenser. Its size does not materially affect the ripple content of the plate supply (filtering is taken care of by C_{19} and C_{20}); its function is to discharge in series with the line voltage and hence bring about voltage doubling action. For that reason an increase in the capacitance of C_{18} may result in improved regulation and slightly higher voltage, but it will not aid much in the reduction of hum. C_{19} and C_{20} are rated at 30 #fd., 300 volts, but if improved filtering is desired, 40 or even 50 #fd. of capacitance can be used. CH_1 is rated at 8 henries at 100 milliamperes, but it was found that the use of a 250 ohm, 10 watt wirewound resistor in place of CH_1 caused very little increase in the ripple content of the output.

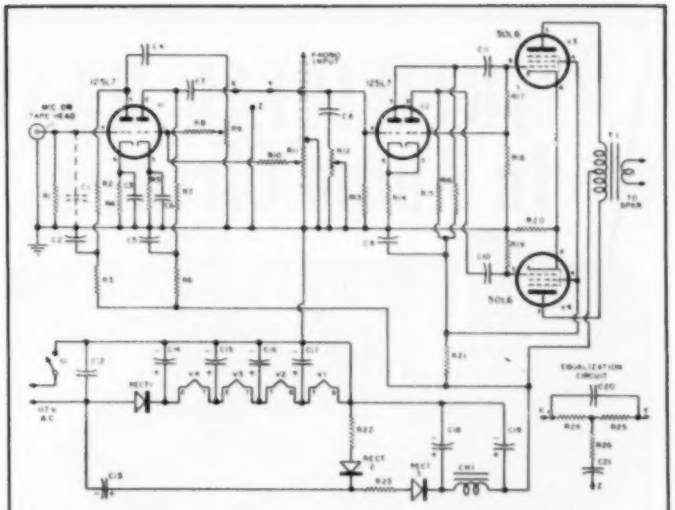
It was obvious that the use of a conventional a.c.-heated series filament string would introduce hum problems, especially as relatively high gain was desired from the amplifier. It was found that the heaters of the tubes could be supplied with pure d.c. very easily and at low cost by using a third 150 milliampere selenium rectifier with a filter condenser across each tube filament to ground. Four such condensers

were used: C_{16}, C_{17}, C_{18}, and C_{19}. C_{16}, C_{17}, and C_{18} are parts of a three-section 150 volt electrolytic condenser with 20 μfd. to the section. C_{19} is a low voltage unit—50 μfd. at 25 volts,—and it is used from the filament of the first 12SL7 (V_1) to ground. This arrangement gives the greatest amount of filtering at the place where hum pickup would be most likely. It will be noted that each of the tubes draws 150 milliamperes of heater current and that the voltage rating of each tube is such that the total voltage drop across the string is approximately that of the line voltage. This set of conditions eliminates any necessity for dropping or shunt resistors. Since the filter condensers are of the "FP" multiple unit type and since the selenium rectifiers are compact and can be easily mounted, the entire power supply, both plate and heater, takes up very little space.

The amplifier as illustrated was built on a chassis measuring 3½" x 11" x 2". This size was desired because of the limited mounting space available for the amplifier in conjunction with the equipment with which it was to be used. If this extreme compactness is not desired, an extra inch in the width of the chassis will allow for somewhat greater ease of construction. However, this size chassis will accommodate all components very nicely if the parts layout, as shown in the photographs, is followed. Since the selenium rectifiers will run quite warm under full load, no ends were used in the chassis, and it was mounted in such a way that adequate ventilation eliminated any possibility of overheating.

At first, miniature tubes were considered for use with this unit, but it was found that the space saved by the size of the tubes was negligible since most of the bulk of the amplifier was due to other components. The first two stages are taken care of with a single 12SL7 which was chosen for its high gain characteristics. Since any high gain amplifier introduces the problem of "motorboating," care was taken to decouple each plate of this tube through a suitable resistor-condenser combination. It was desired to mix the signals from a microphone and phonograph using separate controls. However, it was not desirable to add a separate tube for this purpose, so this mixing was accomplished by using isolating resistors R_7 and R_{10} in their respective control circuits. This method gives very satisfactory results and very little interaction between controls is noticeable.

Although all ground leads are brought to the chassis—a practice not always followed in high-gain amplifiers—little hum appears to be picked up in this way. This is probably due to the absence of a.c. gradients in the chassis due to the d.c. filament supply. However, to guard against ground loops, etc., all grounds for each tube were made at one common point, that is, all grounds for V_1 were made at one point on the chassis, all grounds for V_2 at another point, etc. Since the amplifier



R_1, R_{12}, R_{13}, R_{15}—220,000 ohm, ½ w. res.
R_2, R_3, R_{14}, R_{16}, R_{18}, R_{19}—470,000 ohm, ½ w. res.
R_4, R_{17}—33,000 ohm, ½ w. res.
R_5, R_{11}—1000 ohm, ½ w. res.
R_6, R_{21}—500,000 ohm vol. control
R_7—500,000 ohm tone control (with S_1)
R_8—1500 ohm, ½ w. res.
R_9—8000 ohm, ½ w. res.
R_{10}—70 ohm, 2 w. res.
R_{20}—3000 ohm, 5 w. res.
R_{22}, R_{23}—20 ohm, 2 w. res.
R_{24}—100,000 ohm, ½ w. res.
R_{25}—550,000 ohm, ½ w. res.
R_{26}—15,000 ohm, ½ w. res.
C_1—.003 μfd., 400 v. cond. (See text)
C_2, C_{11}—10/10/10 μfd., 300 v. elec. cond.
C_3, C_4, C_{12}—50 μfd., 25 v. elec. cond.
C_5, C_6, C_{13}, C_{14}, C_{15}—.1 μfd., 600 v. cond.
C_7—.05 μfd., 600 v. cond.
C_8—40 μfd., 150 v. elec. cond.
C_{16}, C_{17}, C_{18}—20/20/20 μfd., 150 v. elec. cond.
C_{20}, C_{21}—50/50 μfd., 300 v. elec. cond.
C_{22}—100 μμfd. mica cond.
C_{23}—.002 μfd., 600 v. cond.
$Rect._1$, $Rect._2$, $Rect._3$—130 ma. selenium rectifier
S_1—S.p.s.t. sw. (on tone control, R_{21})
CH—8 henry, 100 ma. filter choke
J_1—Pin jack for mike or tape head input
T—Output trans. to match push-pull 50L6's to speaker v.c.
V_1, V_2—12SL7 tube
V_3, V_4—50L6 tube

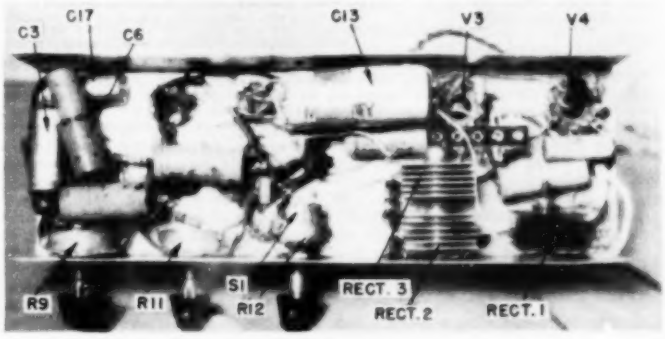
Complete circuit diagram and parts list covering the high-gain amplifier unit.

was to be mounted in a wooden case and the mike and phono plugs mounted on the panel of the case, a pin plug was used in the chassis to take the mike lead from the jack on the case, and a shielded wire was run from the chassis to the phono jack on the case. The builder can follow this procedure or he can mount jacks on the chassis, depending upon the application of the amplifier.

It was assumed in writing this article that most of the readers who might be interested in the construction of the amplifier would need such an amplifier for mike and phono work only. For that reason, the schematic is shown without equalizing circuits, as those needed will vary with the various equipment used. However, plenty of gain is available to take care of any loss introduced by an equalizing circuit should the builder desire to use one. The insert accompanying the schematic diagram of the amplifier shows one type of equalizer which can be included if desired. Since this amplifier is used to play back tape recordings, the equalizer was inserted in the author's

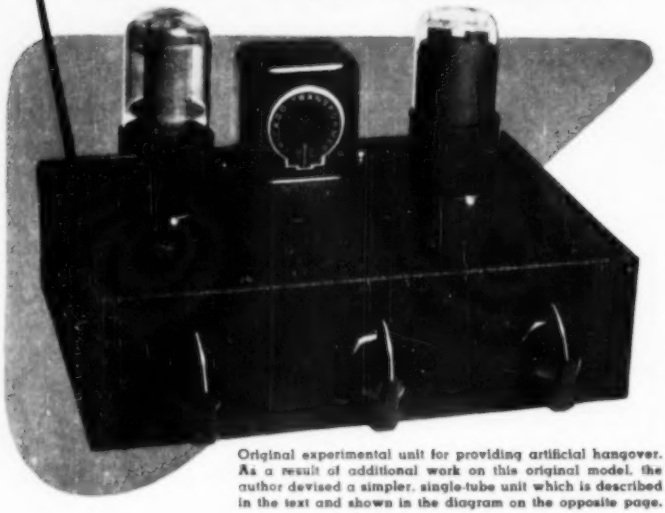
(*Continued on page* 140)

Under chassis view of amplifier with the principal components identified.



ARTIFICIAL HANGOVER In Audio Circuits

By
GLEN SOUTHWORTH



Original experimental unit for providing artificial hangover. As a result of additional work on this original model, the author devised a simpler, single-tube unit which is described in the text and shown in the diagram on the opposite page.

Design data on a novel experimental unit. Controlled hangover adds depth to tonal quality of your system.

SINCE the earliest days of formal music reproduction one of the most serious problems facing both the musician and listener has been that of proper acoustics. The concert hall must be considered as more than a device to keep out the weather inasmuch as it can strongly affect both the audibility and the tonal character of the instruments playing therein. In the home reproduction of music this factor is a serious though often little recognized problem.

In considering speech or music in terms of the relative audibility of various frequency ranges, attention must be paid to the fact that the ear judges the apparent strength of sounds on the basis of the average power contained in the tonal envelope rather than the peak power produced. As a result, a sound of very high intensity but short duration may produce no greater audible effect than a tone of relatively low peak intensity produced for an appreciable interval of time. This is a very important factor in musical reproduction or the enjoyment of live music, inasmuch as the ratio of peak-to-average power of virtually all orchestral instruments is relatively great. The result of this factor is that the audibility of an orchestra and the apparent balance between various instruments is very strongly influenced by the additional *average* power content given to transients by the acoustic "hangover" or echo produced by the acoustic environment. An example of this is shown in the accompanying diagram in which it will be noted that a linearly damped wave train of ten cycles will contain five times the average energy as a pulse of a single cycle, even though the peak power handled is no greater.

Aside from the additional emphasis of certain transients another beneficial result may be obtained from good acoustics. When listening to live music under conditions in which no hangover is present, such as an outdoor concert, a pronounced difference in the character of various instruments can be noted. In the case of instruments producing relatively strong modulations, such as the percussion, tubas, etc., the nonlinear characteristics of the listener's ear may cause him to hear "sidebands" or undesirable frequencies considerably removed from the fundamental tone of the instrument. Virtually all of the instruments which produce acoustic output in the lower octaves will generate modulated wave trains and due to the greater sensitivity of the ear to high frequencies the upper sidebands may produce the greatest audible effect, with the result that the listener may perceive negligible low register output in the music. A good concert hall will tend to reduce the audible effects of steeply modulated wave trains, due to the relatively long decay period of the room which tends to demodulate the wave train, and thus makes possible a more accurate perception of the fundamental tone generated by the instrument.

In considering home reproduction of music a rather complex problem is presented in that for optimum reproduction the original sound should be matched in character to the acoustics of the room in which it is to be reproduced. Much of present day program material would be thoroughly acceptable if played over high quality equipment in a large hall, but is greatly out of place if played over the same equipment in a small living room. One tentative solution to the problem of the small listening environment, currently offered by some American and European recording companies, is to make the original pickup with a microphone placed near the rear of the concert hall. In this way the low frequency decay characteristics of the original hall are included in the recording and tend to compensate for the lack of low frequency reenforcement in a small living room. Although representing a distinct improvement there are several possible drawbacks including interference between the two sets of acoustics and the need for good linearity in the reproducing chain.

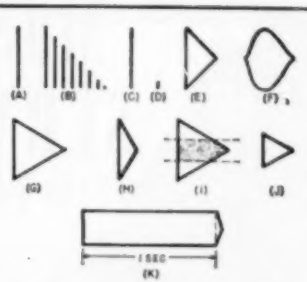
ADVANTAGES OF ARTIFICIAL, CONTROLLABLE HANGOVER

CORRECTION FOR ROOM ACOUSTICS
CORRECTION FOR NOISE LEVELS, NONLINEARITY, VOLUME LEVELS
CAN IMPROVE CHARACTER OR QUALITY OF INSTRUMENTS
CAN GIVE CORRECTION FOR LACK OF TRANSIENT RESPONSE IN LOUDSPEAKERS
GIVES GREATER SPEAKER AND AMPLIFIER EFFICIENCY
REDUCES EFFECTS OF MODULATION DISTORTIONS
CAN IMPROVE APPARENT SIGNAL-TO-NOISE RATIO
CAN PRODUCE INCREASED APPARENT DYNAMIC RANGE
SMOOTHS OUT AUDIBILITY VARIATIONS CAUSED BY RESONANCES
ACTS AS A TONE CONTROL AFFECTING ONLY TRANSIENT WAVEFORMS

Once it is realized that both musical character and the apparent balance between various frequency ranges depends to a very large degree upon the relative duration of transient sounds, then it becomes obvious that an extremely useful technique in correcting for acoustic deficiencies may be obtained by introducing artificial, controllable decay characteristics in the reproducing system. Such a system may be easily devised using an electrical delay network and feedback system closely analogous in operation to the effects produced by conventional acoustic environments. A system of this nature provides a new and useful type of "tone" control, which has only incidental relationship to the conventional variable equalizer, and which appears to more closely produce the effects desired by the listener's ear.

Up to the present time "hangover" in an audio system has been judged undesirable due to the fact that it may take several objectionable forms. One of the primary examples of this is in the case of a sharply tuned circuit, either electrical or mechanical, which tends to produce hangover emphasizing only a single frequency. This produces an unwanted effect and is additionally aggravated by the fact that such circuit elements often can be shock-excited into ringing by an unrelated tone. Similarly, such circuit elements often require appreciable time to build up to maximum amplitude, with the result that the initial portions of a transient wave train may be highly distorted.

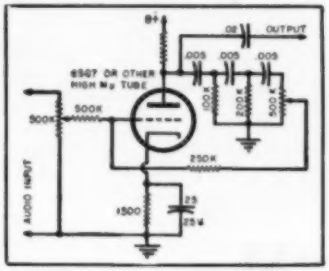
When circuits are designed specifically for the purpose of producing hangover, the previously mentioned characteristics may be eliminated. Smooth decay characteristics may be obtained over an appreciable number of frequencies, there are no ringing resonances to be shock excited, and very little distortion of the initial cycles of the transient is produced. A very simple circuit for producing controlled hangover over a limited frequency range is shown in the accompanying diagram. The circuit shown is a variation of the little known phase delay oscillator. The principle of operation is that the output signal is delayed at least one-half cycle and then fed back to the input. The effect produced is quite different from conventional positive or negative feedback, wherein only the polarity of the signal which is fed back is altered. In the phase delay system a signal will continue to recirculate through the amplifier for a period of time after the original excitation has ceased. The length of time that the signal will continue is dependent upon the gain of the feedback loop, which of course can be made greater than unity at a given frequency, and in which case sustained oscillations will take place. In the circuit shown, a simple three element *RC* delay network is used to obtain artificial delay characteristics over a limited frequency range. Networks handling a wider range of frequencies



(A) Single impulse. (B) Damped wave train produced by impulse. The average energy content of (B) is five times as great as (A). (C) Electrical input to a speaker with poor transient response. (D) Acoustic output of same speaker. (E) Damped wave train applied to same speaker and the resultant acoustic output (F) which contains a closer relationship to input signal in terms of average energy. (H) represents loss of duration of signal (G) when passed through a nonlinear system. (I) is condition of system in which a low amplitude cut-off exists with resultant attenuation shown in (J). As many transient wave trains decay exponentially the effect on the over-all duration of sound may be much more serious. (K) The relatively slight deformation of envelope shape produced by ten cycles of hangover on a 500-cycle tone of one second duration, thus showing small effect of hangover on tones of a continuous nature.

may be devised but require additional gain and circuit complexity. Ideally, a circuit should be available to produce 180 degrees or more constant phase shift over the entire audio range without any attenuation, as this would allow hangover to be applied to all frequencies simultaneously. In practice, however, it will more usually be desired to emphasize certain frequency ranges to fill in "gaps" in the hangover pattern of the acoustics. In the case of small rooms, one of these gaps will be in the region below about two or three hundred cycles where the dimensions of the room are insufficient to offer any sort of reinforcement. Regarded from this standpoint, a rationalization appears to exist for the popularity of some commercial radios in which strong cabinet and loudspeaker hangover produces the semblance of some low frequency response in small rooms. The results produced by the electronic hangover method are much superior and make it possible to get good, clean, audible bass reproduction in small areas without resorting to extremely high volume levels, conventional bass boost circuits, or other methods.

In designing a delay network for an artificial hangover system, a phase shift of 45 degrees per section will occur when the reactance of the condenser leg is equal to that of the resistive leg and increases with an increase in condenser reactance although the output voltage available from the network will decrease. In the one tube circuit shown, the circuit elements are proportioned so that hangover takes place below 200 cycles. If it were desired to introduce hangover in the high frequencies, for example around 2800 cps in order to emphasize the "brass" instruments, then the circuit elements of the delay network should be altered until the reactance of the capacitive elements is about equal to that of the resistors at that frequency. With the circuit shown, it appears to be desirable to use dissimilar elements in the three legs of the delay network, both to get operation over a wider frequency range and to reduce the loading effect of one section on the others. Similarly, with the circuit shown, it should be noted that



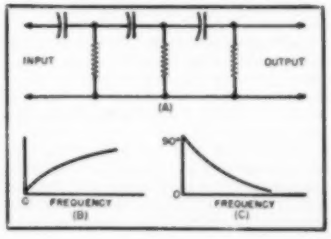
Schematic of simple one-tube circuit for obtaining controllable hangover over a limited frequency range. Circuit constants shown are for the range below 200 cycles.

the frequencies above the point of operation of the phase shift network are fed back essentially 180 degrees from the input, with the result that they suffer attenuation.

Circuits with phase delay effects sometimes exist in conventional amplifier systems and may give the effect of superior bass reproduction due to the hangover produced. One example of this is the case of an amplifier using inverse feedback over several stages having small coupling condensers. Another example is the multistage amplifier in which a relatively small capacity is used in the plate filter circuit and insufficient decoupling is present. In order to prevent this effect, if it is considered undesir-

(*Continued on page* 103)

(A) Simple form of delay network. Phase shift per section equals 45 degrees when reactance of condenser and resistor is equal. (B) Gain characteristics of the phase shift network (1 leg). (C) Phase characteristics of one leg of delay net.



Mac's RADIO SERVICE SHOP

By JOHN T. FRYE

SOMETHING BORROWED

"WHEW! What a day!" Barney exclaimed as he stamped into the service shop brushing the snowflakes from his wool jacket. "If it keeps on snowing like this all day, a man is going to have to have a dog-team to get home tonight — s-a-a-a-y," he broke off as he stepped into the service department, "what have you been up to over the weekend? I can't tell if I'm in a radio store or a barber shop! Where did you get all that mirror behind the bench?"

"Like it?" Mac, Barney's employer, asked with a self-satisfied grin. "A little barber shop over on Seventeenth Street just closed up, and I bought the big mirror very cheap because of a couple of small flaws in it. After I had these cut out, I still had left two mirrors six feet long and two-and-a-half feet wide. That is just right to give us a continuous mirror behind the whole length of the service bench."

"I'll say I like it," Barney exclaimed as he leaned forward for a closer admiring inspection of his reflection. "It will be a real pleasure to do servicing with a handsome devil like that working opposite me all day long."

"All right, Narcissus; but that was not quite the idea," Mac drawled. "I simply grew tired of squinting into a small mirror and trying to get a good view of a TV screen while I was making adjustments on the set. No matter how hard I tried, I never seemed to be able to tilt the mirror so that I could see the exact corner of the tube I wanted to see. Now we've really got that whipped."

"Yeah, and that mirror will be the old mustard for working on record-changers," Barney pointed out. "When the changer is sitting on a stand on the bench, a guy will be able to see what is going on on both sides of the mechanism at the same time; and believe me with a lot of changers these days, you almost have to be able to do just that."

"There's still another good feature I've found out," Mac added. "You know how tools and screws and parts dearly love to hide by snuggling up against the far side of a chassis on which you are working, don't you? Well, they won't be able to do that on this bench. With that mirror to let you see the surface of the bench from dozens of angles, not even a knob set-screw can hide. It is almost as good as having an extra eye on the end of a stick that you can poke around behind the chassis."

"That's a gruesome way of putting it," Barney commented.

"That's not the only haul I made at the defunct barber shop," Mac said over his shoulder as he disappeared into the storeroom. "Take a look at this," he said as he reappeared pushing what looked like the granddaddy of all flower stands. "The guy had a dilapidated old barber chair that he said I could have if I wanted it; so I brought it along, discarded the chair part of it, mounted this thirty-inch-square platform solidly on the old chair-supporting bracket, and then put those four heavy-duty casters underneath the base."

"Fine, but what's it for?"

"For holding a TV chassis while you're working on it," Max explained. "That weighted base makes it almost impossible to push over; the platform can be pumped up or let down through a range of several inches so that it will be just the right height for comfortable working; and the set can be easily twirled around to any position. Instead of having to drag a heavy chassis all over the work-bench, we simply roll this dolly up to whatever instrument we want to use. When we need to make adjustments both above and below the chassis in rapid sequence, the set is placed on its side on the platform and then any part of it is easily and comfortably accessible simply by turning the platform."

"Let me try it," Barney begged as he sat down on the platform and whirled himself around. "I always did want to do this with a barber chair but never got the chance. Wh-e-e-e! This is fun! Did you steal any other ideas from the barber shop?"

"No, but I've been snooping around some other 'service' concerns in search of tools or ideas that I could borrow for doing radio and TV service, and I've come up with several that are well worth adopting. Take this jeweler's loupe, for example," Mac said as he screwed the black magnifying eyepiece into his eye-socket and peered owlishly through it at his assistant. "It really is the thing for finding a broken coil end, for discovering a tiny chipped place on a jeweled pickup needle, or for examining a TV tuner mechanism for dirt and corrosion. This one focuses at a distance of about five inches from the eye, which my jeweler told me would be the best for all around work; but they come in various powers. I think that we shall need an eye-aid of this sort more and more in the future. The Signal Corps admits that much of its present effort is directed toward miniaturization of equipment. Judging from the few samples of this effort we have seen in magazines, the eye is going to need all the help it can get to see trouble in the midget components and printed circuits that will go into civilian sets in the not-too-distant future.

"And here is another little sight-aid I picked up from the doctors and dentists," he went on as he self-consciously slipped on a head-reflector and carefully adjusted the mirror so that it shined directly into Barney's blinking eyes. "One thing a technician never has enough of is hands, and when all ten of your fingers are busy in a dark corner of the chassis this handy little gadget will light up that corner just as well as you could do with a third hand holding a flashlight."

"Yes, Doctor," Barney mockingly agreed.

Mac slipped off the reflector and picked up three shiny little steel rods. "You probably have seen something like these before," he said to Barney. "They are the instruments the dentist uses to break loose the calcium deposits from teeth, and they are surprisingly strong."

"I'll say they are," Barney agreed with feeling. "I've had a dentist lift me right out of the chair with one of those nasty little cusses."

"Their toughness and small size makes them ideal for working over loose tube socket contacts, bending switch contacts back in place, and per-

(*Continued on page* 134)

CRYSTAL DIODES In Modern Electronics

Several banks of assembly machines at the Clyde, New York plant of General Electric Company. This factory is devoted exclusively to the manufacture of germanium assemblies and other similar products.

By
DAVID T. ARMSTRONG

Part 1. Various applications of germanium crystal diodes as employed in present-day FM circuitry.

IT IS assumed here that the reader has a basic understanding of FM and that he is familiar with the function of limiters, frequency discriminators, and ratio detectors. These are the important parts of an FM circuit in which crystals are beginning to play a significant role. Only those aspects of circuit considerations will be treated here which deal specifically with the application of germanium diodes to functions heretofore performed entirely by diode tubes of the 6H6 and 6AL5 types.

Crystals function exceptionally well in any type of FM circuit, on i.f.'s ranging from the 4.5 mc. of the intercarrier sound system, through 10.7 and 25.75 mc., to the new 44 mc. frequency now coming into use in modern television receivers. The FM section may be a distinct entity of an FM receiver, or it may be the FM sound system in a modern television circuit. The material presented here applies equally well to any type of modern FM circuitry.

Limiter Circuits

One of the basic requirements of an FM system is a limiting device to eliminate amplitude variations before they reach the detector. The function of the limiter is to remove amplitude modulation and to pass on to the detector a frequency modulated signal of constant amplitude. To operate successfully, the limiter must be supplied with a sufficiently large signal voltage so that the amplitude of its output will not change with rather wide variations in signal amplitude. Noise, which causes little frequency modulation but much amplitude modulation of the received signal, is virtually wiped out in a limiter stage. Automatic volume control may be used with an FM receiver, but when a limiter is operating properly, a.v.c. is neither necessary nor desirable.

The limiter is part of the final i.f. amplifier stage; its main function is to remove amplitude variations which might reach the detector and appear as distortion in the audio output. The limiter, then, is a gate which removes amplitude variations from a signal above a predetermined level and passes on a signal that is constant in amplitude.

The positive and negative peaks of the FM signal will be truncated and flattened. See Fig. 1. This does not introduce distortion into the FM signal as it might in an AM signal because the modulation component or intelligence is contained in the frequency deviations of the signal and not in the amplitude variations of the signal. Frequency deviations due to modulation are not affected by limiter action.

The actual FM response curve is neither ideal nor flat topped. Hence the various frequencies making up the total frequency deviation will not have the same relative amplitude at the input to the limiter. The center frequency and the frequencies close to it will have greater amplitude than those considerably removed from the center frequency due to the action of the i.f. tuned circuits. This is demonstrated in Fig. 2. The unequal amplitude of the various frequencies appearing at the input to the limiter would cause severe distortion if something were not done in the receiver to compensate for it.

A limiter is sometimes regarded as a device for removing all noise. This is not so. A limiter will function efficiently (but not perfectly) when the voltage level (amplitude) at the input to the limiter of the greatest frequency deviation component (this is the frequency ± 75 kc. from the mean frequency) is greater than the limiting level. Limiter output will be constant when a total band of 150 kc. is passed at a constant level, for then all the frequencies making up the total deviation will be reproduced in their proper relation, and without distortion due to AM or random noise.

The limiter characteristic represented by the graph at *A* in Fig. 2 will permit AM distortion because the i.f. signal is below the limiter level. Note that the limiter level is gauged by the characteristic curve of the voltage-fre-

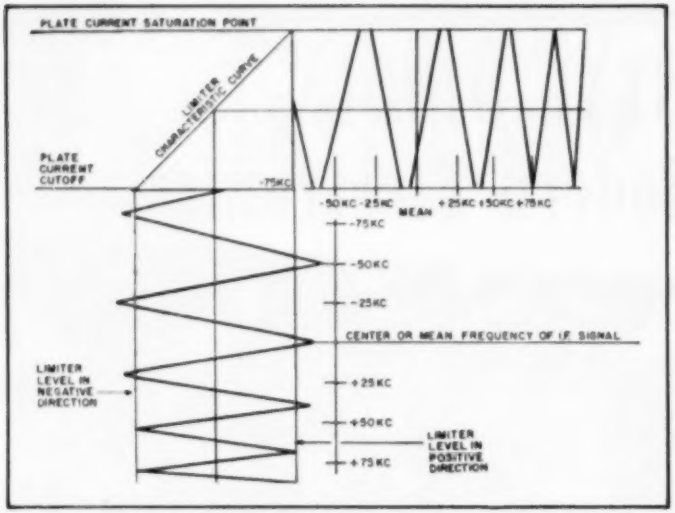


Fig. 1. Limiter action for a strong I.f. signal. Note that the amplitude of the input wave at the highest frequency deviation components of the FM wave is above the limiter level, and that the input level of the I.f. signal over the entire range of the frequency deviations is above the limiter level. Also note that positive and negative peaks of the output FM wave are truncated. The output of the limiter is constant over the entire range of the frequency deviation.

quency graph. The signal at *B* will permit no distortion because the lowest signal input level is above the limiter level. Hence all AM components and/or random noise are "hedge clipped" by the action of the limiter.

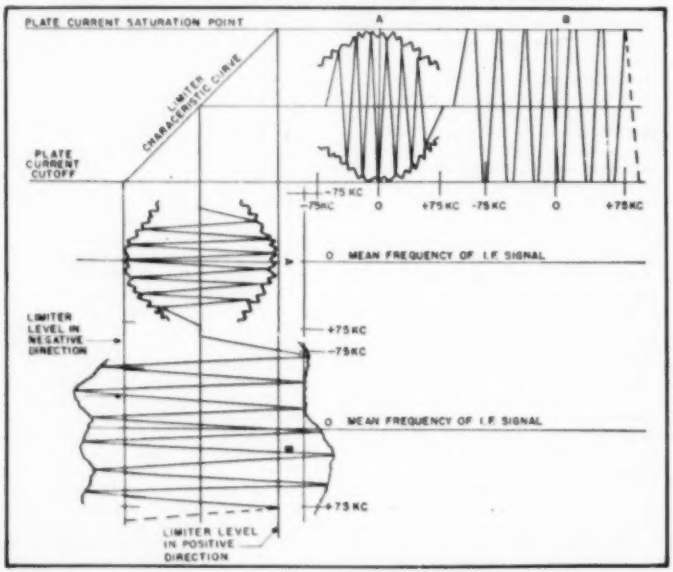


Fig. 2. Effect of limiter action on varying limiter input signals. (A) Noise voltage reproduced in the output of limiter. (B) Noise is removed by limiter action, wave is truncated. Note that when the input level of the I.f. signal over the entire range of frequency deviation is above the limiter threshold, as in (B), no noise voltage is reproduced in the output of the limiter but when the input level of the I.f. signal is below the threshold of limiter action, the limiter cannot function and the noise will be reproduced as shown in (A).

Diode Dynamic Limiter

Any residual amplitude modulation and noise riding the FM wave should be suppressed. The limiter component desired must be an effective supplement to the action of the FM detector to reduce random noise and AM interference. This is necessary because a balanced discriminator completely suppresses AM at but one frequency, and a ratio detector is critical to align and balance. Maximum AM rejection may not occur at that alignment adjustment which provides the most desirable linearity.

It is of course recognized that a cascade type grid bias limiter is capable of nearly complete AM suppression; but two additional tubes are necessary and this type of circuit is relatively expensive. A comparative set of curves for one diode, two diodes, and a cascade limiter is shown in Fig. 3. The single and double diode curves are variable threshold devices that show AM reduction factors ranging from 6 to 10 db better than the cascade limiter for signal levels below the threshold of the cascade type limiter.

Fig. 4 shows a dynamic limiter circuit employing a type 1N48 or 1N56 as the germanium crystal diode. This is a simple and highly effective type of amplitude modulation limiter for both an FM receiver and a TV sound channel. This limiter provides a variable threshold action that extends to small signal levels and effects a significant degree of quieting on weak signals as well as for interchannel background noise.

Any signal of such peak amplitude as to be above the threshold level will have its residual amplitude variations suppressed by this limiter. The ideal limit of suppression may be more nearly approached by a germanium crystal than by a vacuum tube, because the crystal exhibits so much greater conductance than a tube. In addition to high conductance, the crystal diode exhibits extremely low capacitance.

This variable threshold limiter device uses a resistance-capacitance network with a time constant long compared to the lowest expected amplitude modulation frequency, and the limiter adjusts itself automatically to the varying average signal amplitude. A time constant of 0.1 second is sufficient to insure rejection of AM components down to 10 cycles.

For a given frequency there is a loss caused by the insertion of a diode in a transmission system. It is the ratio, expressed in decibels, of the power delivered before the insertion to the power delivered after the insertion; this is commonly referred to as "insertion loss." Since for any given signal level the insertion loss of the limiter becomes greater as the resistance is reduced, the resistance value is governed by the allowable limiter insertion loss and the desired degree of small signal AM rejection. 10,000 ohms is a reasonable compromise among all the factors which obtain.

To achieve a time constant of 0.1 second the value of the electrolytic type condenser then becomes 10 μfd.; for a 20,000 ohm resistor it would be

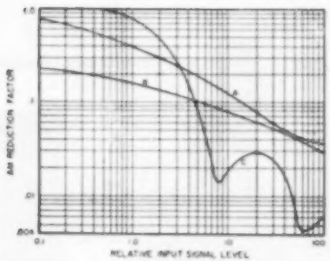


Fig. 3. Comparison of single and double diodes with cascade type grid bias limiter. (A) Single diode dynamic limiter (1N56). (B) Double diode dynamic limiter (2-1N56's) and (C) Cascade limiter using 2-6SJ7 tubes.

5 μfd. The small 500 μμfd. mica condenser bypasses the high frequency i.f. components.

With this type variable threshold limiter AM reduction varies smoothly with signal level, AM noise decreasing as the signal level increases, and approaching zero as the signal voltage is increased by virtue of improvement in crystal efficiency at high signal voltages.

The biased high conductance diode 1N48 or 1N56 is shunted across the tuned circuit which is the primary of the detector input transformer, either limiter-discriminator or ratio detector type. Whenever the "*Q*" of the tuned circuit exceeds 25, the damping provided by the diode is effectively integrated over the i.f. cycle. Voltage regulation is predominantly in the tuned circuit, and the diode helps maintain essentially constant voltage across the circuit.

This type dynamic limiter is not critical with respect to characteristics of the particular crystal employed; virtually any germanium diode will perform well in this circuit. This is a worthwhile consideration in connection with replacement of one unit by another. Further, the back resistance of the crystal also serves to augment the action of the limiter. Finally, a receiver using a dynamic limiter would require only ½ to ⅓ the input signal voltage at the antenna to produce a given amount of quieting.

Of course this limiter is not capable of as great AM suppression as the cascade grid bias type limiter. However, the variable threshold action tends to extend the range of operation to low signal levels. Thus the use of such a dynamic limiter in simplified FM receivers is attractive because of the significant quieting on weak signals, even with but slight over-all gain. In the absence of a signal some squelch action occurs as a result of partial limiting on receiver background noise.

In a TV receiver with intercarrier sound this type dynamic limiter helps to reduce the audio buzz which sometimes accompanies excessive modulation depth of the picture carrier.

The double diode dynamic limiter circuit shown in Fig. 5, used in conjunction with an FM detector, helps suppress residual AM in frequency modulation type receivers or sound circuits of TV receivers. A high conductance diode like the 1N56 provides exceptionally effective limiter action, particularly at signal levels as low as 5 volts or less. The low dynamic impedance and the low diode capacitance produce a minimum of reactive loading across the source and minimize any loss traceable to limiter insertion at low signal levels.

The two biased diodes are so polarized that they conduct in opposite directions. The net improvement in AM reduction factor (ratio of the percentage modulation of output signal to input signal) is so exceptional that it is shown graphically in Fig. 6.

Many television receivers use a limiter stage ahead of the discriminator, even when a ratio detector is used as the detector. The function of the limiter is to clip off any amplitude variations of the sound i.f. signal that may be caused by noise or non-uniform i.f. amplification over the frequency band. Wherever the normal amplification of the grid biased limiter is not necessary, a biased diode may be used more economically.

The basic limiter circuit in Fig. 4 illustrates this effectively. The diode with a bias voltage equal to the normal signal level is placed across a tuned circuit. The diode will conduct only on peaks that exceed the normal signal level; hence noise peaks will be automatically shorted out. Harmonic distortion as a result of such clipping action may be minimized by using two diodes to clip both the positive and negative peaks, as in Fig. 5. This is, in effect, a full-wave limiter.

The bias is usually obtained from an *RC* circuit so designed and with such a time constant configuration that it automatically adjusts itself to the signal level. This use of crystal diodes is one of the most inexpensive means of securing desirable limiter action. These germanium diodes are quite likely to be used widely in discriminator circuits. They may be wired directly to the transformer and mounted in the shielded can to facilitate elimination of contact potential feedback and filament hum problems.

Discriminator Circuits

One of the basic requirements of an FM system is that the detector be a device for converting frequency changes into amplitude variations which may then be amplified as audio signals. In the widely used Foster-Seeley discriminator the signal frequency varies back and forth across the resonant frequency of the discriminator and an a.c. voltage of the same frequency as the original modulation is developed and passed on to the audio amplifier.

The discriminator in an FM circuit corresponds to the detector in an AM circuit in that both demodulate the intelligence from the carrier wave. The process is different, but the net

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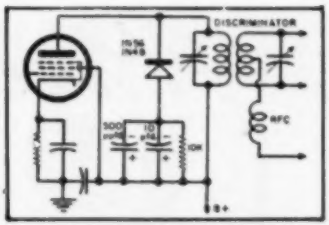

Fig. 4. Single diode dynamic limiter. The values of the 10,000 ohm resistor and the 10 μfd. condenser may be chosen to suit the signal frequency and degree of clipping desired. Values of the resistor may range from 5000 to 50,000 ohms. Condenser values will depend on the time constant desired. The time constant of this circuit is approximately 0.1 second. Where high impedances are desirable G-E types 1N52 or 1N63 or Sylvania type 1N54 may be employed.

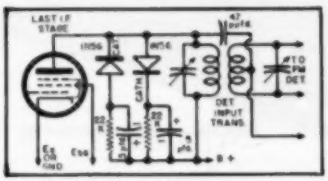

Fig. 5. Double diode dynamic limiter circuit.

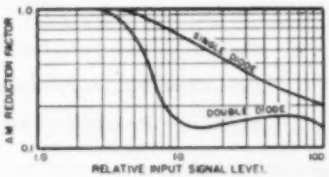

Fig. 6. Comparison of AM reduction factor for single and double diode dynamic limiter.

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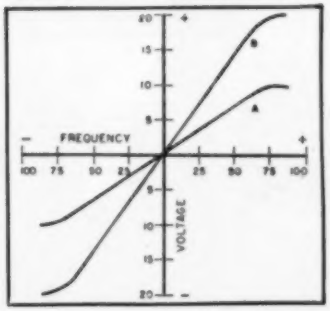
Fig. 7. Characteristic curve for a discriminator. Note that output voltage of unit is greater for a high input voltage level as shown in curve B as compared with lower input level for curve A. Also the quality of response depends on linearity of curve from −75 kc. to +75 kc. deviation from center frequency of i.f. response. This graph demonstrates that output of the discriminator may vary with changes in signal level (which is AM variation since curves for B and A show characteristics for different signal levels).



Practical SOUND ENGINEERING

Fig. 1. Part of equipment in power room at Republic Studios in Hollywood. Four 35 mm film recorders and a disc recorder are employed.

By

H. M. TREMAINE, D.Sc.

Audio Consultant

Part 11. The concluding article of this series detailing how a complete distribution system achieves flexibility by means of patch bays.

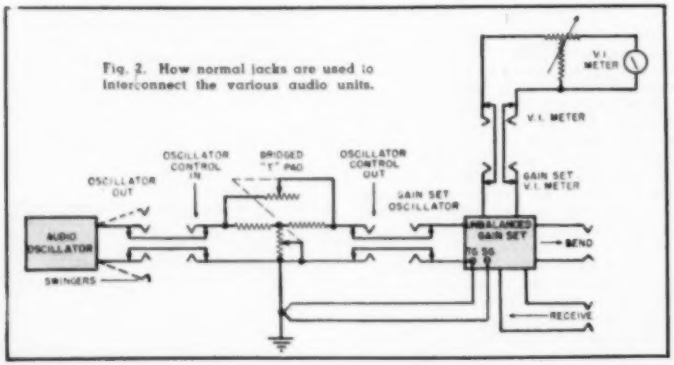
CONVENIENCE of operation and flexibility are the main factors which have resulted in the development of the patch cord, jack strip, and patch bay. The term "bay" originated in the telephone industry, and is used to designate a group of racks. Thus, a patch bay or amplifier bay may be one or several racks containing similar type equipment.

Fig. 3 is a typical motion picture sound recording installation at the *Republic Studios* in Hollywood, California. The equipment pictured is used for the recording of music, re-recording, and "dubbing," and represents four complete recording channels. The first two racks at the left contain microphone preamplifiers and phototube preamplifiers used with the film reproducers shown in Fig. 5. The next two racks contain the recording and compressor-limiter amplifiers for channels 1 and 2. Racks 5 and 6 house the "transmission" measuring equipment consisting of a gain set (transmission set), distortion factor meter, filters, repeat coils, audio oscillator, and two special low-noise amplifiers for film measurements. Racks 7 and 8 contain channels 3 and 4, which are similar to the other two channels. The next four racks hold four 60-watt monitoring amplifiers and associated equipment. Two racks which are not shown contain signal and talk-back equipment.

For flexibility all equipment is interconnected by a system of "normal jacks." Except for the monitor amplifiers, all equipment is operated from high and low voltage d.c. power supplies situated in a power room in another part of the building. This type operation and design prevents the picking up of stray magnetic fields. Each group of power supplies is fed from a constant source of a.c. voltage through voltage regulators. On the right-hand side of the room are four 35 mm film recorders and a disc recorder, shown in Fig. 1. The rack at the right end holds the noise reduction amplifiers for the film recorders and a "cross-modulation" oscillator for film processing tests. The recorder motors are driven from master distributor systems, controlled from the panel at the extreme right.

The greater percentage of circuit jacks found in sound installations and audio frequency laboratories are of the "normal" type. These jacks are designed to permanently connect various pieces of equipment which are used in conjunction with each other for the making of measurements or other purposes. The equipment so "normalled" may be used as a complete unit without the necessity of connecting them by means of patch cords. When desired, however, any one of the units connected to the jacks may be used individually. Figs. 4A and 4B show the physical construction and circuit connections of two jacks, a "normal" and an "open circuit" type.

Fig. 2. How normal jacks are used to interconnect the various audio units.



It will be noted that the normal jack differs from the open circuit jack in that it has a small inner leaf spring called the "normal spring" and is normally in contact with the upper spring, known as the "swinger." This inner or normal spring is not used in the open circuit type jack.

When it is desired to continuously operate a number of circuits or pieces of equipment together, normal jacks are employed. The normal springs (inner) are connected so as to form a continuous circuit from one pair of jacks to another. For example: an oscillator, oscillator output control, gain set, and a v.i. meter are generally used together in the making of gain frequency measurements.

Fig. 2 illustrates the manner in which normal jacks are used to connect these pieces of equipment together into a continuous circuit, so that all units are permanently interconnected, yet may be operated independent of each other, if desired. The use of normal jacks also provides a means of substituting equipment in case of failure of any one unit normally used. The normal springs of the jacks at the output of the oscillator are connected to the normal springs of the oscillator control input jacks. The output of the control is then normalled to the gain set oscillator jacks.

When it is desired to pick up only the oscillator, a patch cord is inserted in the oscillator output jacks. When the tip of the patch cord plug enters the jack, it moves the "swingers" outward, breaking the circuit between it and the normal spring, as shown by the dotted lines in Fig. 2. This action disconnects the oscillator output from the oscillator control, and allows the oscillator to be picked up independently of the control. The same action will take place if a patch cord is inserted in any other portion of the circuit.

When it is desired to connect several circuits or pieces of equipment in multiple (parallel) by means of patch cords, a "strap jack" is employed. Strap jacks consist of several open circuit jacks connected in parallel, as shown in Fig. 8B. Frequently, several such strap jacks are included in an installation to facilitate the interconnection of equipment. Generally, a group of five constitute a strap; at least one strap jack is included in each group of high or low level jacks.

Jacks may also be referred to as "multiples." This type connection differs from the strap jack in that it is connected permanently in parallel with a particular circuit or piece of equipment to provide additional connections. A multiple connection is shown in Fig. 8A.

Patch cords employed in the transmission laboratory, as well as in other parts of the plant, may be single (tip and sleeve) or double circuit type, as shown in Figs. 6 and 7. A single circuit plug consists of a brass "sleeve" and "tip." A small rod connects to the tip, and runs back through the brass sleeve through an insulated bushing to the "body," where a terminal screw is provided for connection to the cord. The sleeve is always connected to the ground, or "low potential" side of the circuit, while the tip is connected to the high potential or "hot side" of the circuit. A bakelite sleeve fits over the rear end to protect the connections inside the body and also to provide a grip for the plug.

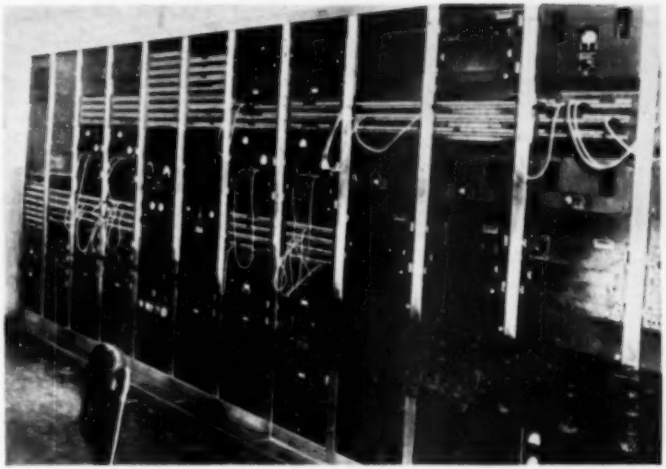


Fig. 3. Typical motion picture sound recording installation at Republic Studios.

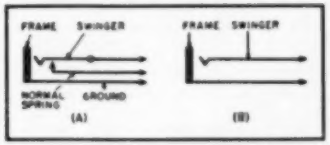


Fig. 4. The physical construction and circuit connections of (A) a normal jack and (B) an open circuit type recording jack.

The double circuit plug is practically standard throughout the recording and broadcast industries. The plug consists of two single circuit plugs in a dual mounting and is similar in all respects to the single circuit plug except that the plug floats in the body and thus allows for variations in jack strip mountings. The bakelite body of this plug has a group of notches on one side to indicate the polarity of the plug. Corresponding jacks are spaced to prevent improper insertion of the plugs.

When patch cords are assembled they are polarized by connecting the corresponding tips and sleeves of each end together through the cord. Single plug type patch cords can only be inserted into a jack one way. However,

Fig. 5. The film reproducers used in connection with the equipment shown in Fig. 3.

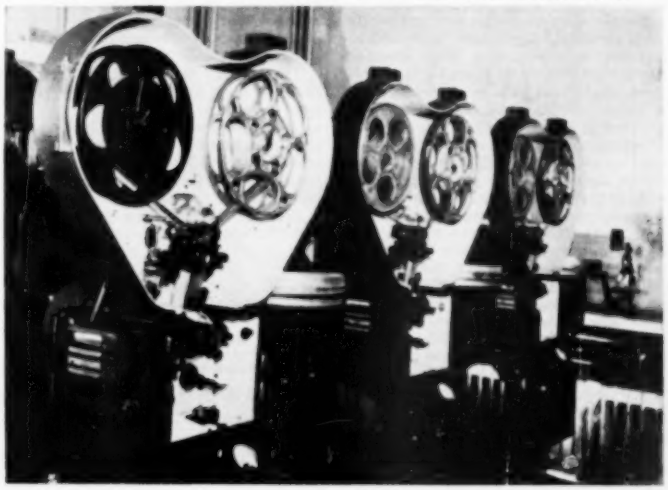


Fig. 6. Double circuit type patch cord.

Fig. 7. A single circuit type patch cord.

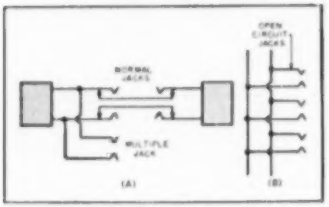


Fig. 8. (A) Method of connecting strap jacks and (B) multiple jack connection.

DEVICE	OUTPUT LEVEL
Mikes	—65 to —50 dbm
Preamps	—20 to — 6 dbm
Mixers	—50 to —20 dbm
Booster Amp.	—30 to —10 dbm
Line Amp.	0 to + 4 dbm
Bridging Amp.	+10 to +30 dbm
Recording Power Amp.	+ 4 to +46 dbm
Monitor Power Amp.	+20 to +46 dbm

Table 1. Approximate circuit levels that may be expected in an average installation.

the double plug can be turned over 180 degrees and thus reverse the circuit. This might upset the circuit balance or short out the signal completely. To prevent this, the circuits to the jacks throughout the installation are polarized by connecting the left hand (facing the rack) jack of a pair to the low potential or grounded side of the circuit. The patch cord plug is always inserted with the notched side to the operator's *left* as he faces the rack.

Single circuit plugs are generally used for signal lights and "order wire" circuits; however, if a large number of circuits are to be placed in a small area, the single jack may be used.

Some of the radio networks have adopted a jack and plug known as a "tip-ring-sleeve" type, which is a three-circuit device. This plug is similar in appearance to the single type, except that between the tip and sleeve is a ring contact insulated from the tip and sleeve. The tip carries the hot side of the circuit, the ring the low potential side, and the sleeve the ground, which is connected to a flexible metal shield covering the cord. A similar type plug is also used for telephone circuits in switchboards. The jack for this type plug has two swingers, one for the tip and one for the ring. The frame is grounded.

Separate ground wires are run to each group of jack frames, and then to the main ground at the bottom of the rack. The low-level ground wires are carried on the left, and the high-level wires on the right.

When signals of extremely low level are carried over patch cords, it is the practice to use a shielded type, thus preventing pickup from circuits of higher level and surrounding equipment. In large installations, all jack frames are grounded and supply a ground for shielded patch cords. However, if the shield of the patch cord is grounded at both ends, it will result in a ground loop between two jack strips; therefore, it is grounded at one end only.

Shielded pairs comprising the cable forms terminate at terminal blocks located at the bottom of the rack. Lines from external equipment and other parts of the installation come to these blocks first, then tie to the proper circuits in the cable forms. Such practices allow equipment to be terminated differently as changes are required in the installation. Circuits carrying d.c. from power supplies and ground wires, are carried in the low level section of the gutter.

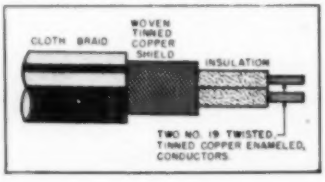
Impedance matching of equipment is of extreme importance in audio installations. If the terminal impedances match the "surge" or "characteristic" impedance of the line, reflections along the line which create a loss of power will be at a minimum, and a maximum transmission of power will result. However, audio engineers deal with relatively low frequencies, 30 to 20,000 cycles, therefore the surge impedance is small and may be disregarded. The line impedance is generally considered to be that of the impedance terminating the line, or very close to it.

If the audio power is one watt (plus 30 dbm) or less, the shielded transmission line shown in Fig. 9 may be used. Circuits carrying higher powers should be of wire that has a very low d.c. resistance per foot, because at high powers this resistance may reduce the energy at the far end of the line by several decibels. For large speaker systems where 50 to 100 watts of power must be transmitted, the lines are generally run in metal conduit using #10 to #14 common rubber-covered wire.

The loss of power due to line resistance may be determined by referring to a wire table, finding the "resistance-per-foot" for a given size and then calculating the power loss. It must be remembered that the line is a pair and the footage is the length for both wires.

It is not good practice to run lines of low impedance (15 ohms or lower) over great distances, as the effective d.c. resistance of the line may become of such value that the impedance of the circuit is upset, in addition to creating a loss of power.

Fig. 9. Construction of a shielded pair.



A better method is to transmit the signal over a 500- or 600-ohm line, and then reduce the impedance at the far end by the use of an impedance-matching transformer. This permits a high voltage-low current transmission of the signal which reduces line losses. In the case of the low-impedance line, power losses are greater because the voltage is low and the current is high, and the d.c. resistance of the line becomes important. Transformers used for impedance matching must have a low insertion loss, to prevent a loss of power.

The percentage of impedance mismatch between different units of an installation may vary up to 10 to 15 per-cent without seriously affecting its operation. Of course, the greater the mismatch, the greater the transmission loss in power. In some instances the frequency response of the device may be affected if the mismatch is too great. If the mismatch is held to within 10 per-cent, it is considered to be satisfactory.

The running of high- and low-level lines in the same cable form should be avoided. High- and low-level lines should not be adjacent to each other unless they are separated by a space of several inches. It must be understood that the shielding on the cable pair provides a fixed amount of "cross-talk" reduction and its effectiveness depends on the level of the signal in the circuit.

As a rule, most low-level circuits may be cabled in the same form when the signal difference is not more than 40 db. If circuits with levels between minus 20 and zero dbm are present in the same area, they must be cabled into separate forms and separated by a distance of one inch or greater.

Sometimes it is necessary to run unshielded a.c. power cable forms inside the frame of a rack. To secure greater separation and to obtain a certain amount of magnetic shielding, the lines are laid in the "channel-iron" sides of the rack. However, it is the best practice to run all a.c. lines either in steel tube or flex at the rear of the racks. The flex is carried from the power source directly to the equipment.

High-level pairs running to loudspeaker systems should be carried as directly as possible to the speakers and run inside the rack frame to prevent coupling to the lower-level pairs.

Circuits carrying high voltage d.c. for plate supply are treated as a low-level line, and run on the *low-level* side of the rack as are d.c. heater voltages.

The values given in Table 1 are not intended to represent any particular installation, but to show the range of levels that may be encountered.

The material contained in this article was supplied by and through the courtesy of Hollywood Technical Institute, 3359 Cahuenga Blvd., Hollywood, California. —30—

Features OF THE NEW 1952 Heathkits

PROOF OF THE NEW O-7 OSCILLOSCOPE'S OUTSTANDING PERFORMANCE

Below are actual, untretouched photographs showing the outstanding frequency response characteristics of the NEW 1952 HEATHKIT OSCILLOSCOPE, MODEL O-7. To the left is a 10 KC square wave — to the right a 4 MC sine wave as they actually appear on the screen. Two highly severe tests to make on any scope (only the best of scopes will show traces like these) — and the O-7 really comes through.

COMPANION VACUUM TUBE VOLTMETERS

Here are the two NEW 1952 VACUUM TUBE VOLTMETER COMPANION PIECES. Matched instruments of new design to open up the whole field of DC, AC, and resistance measurements for you. The new greatly reduced size combines style, beauty and compactness — The V-5 and AV-1 have the new panel and cabinet construction as shown at the right. A tremendous part of voltmeters. Small in size but virtual giants in the range of measurements they make.

NEW STYLE AND BEAUTY

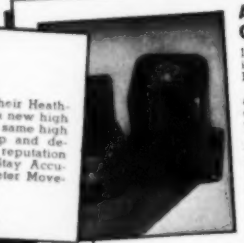
Style that's modern, yet functional — that's the trend of today — and Heathkits are right up to the minute. Note the cut showing the new V-5 and AV-1 cabinet and panel construction. The front panel and rear cover slide right over the recessed flange of the case thereby eliminating sharp edges and pointed corners. The voltmeter kits aren't "shelf" or mounted" instruments — they're moved about on the bench a lot and thus the new compact size and specially designed cabinets — Another 1952 Heathkit feature.

A STATEMENT FROM SIMPSON ELECTRIC CO.

In choosing Simpson Meters for their Heathkit VTVM, the Heath Co. has set a new high standard of kit meter quality. The same high quality of material, workmanship and design that has given Simpson the reputation for building "Instruments That Stay Accurate" is found in the Heathkit Meter Movement.

SIGNED
SIMPSON ELECTRIC CO.

A STATEMENT FROM CHICAGO TRANSFORMER



It is indeed gratifying to note the outstanding sales records you are building with your Heathkits.

This sales success is readily understandable, since we are cognizant of the high quality standards you have established for your component suppliers.

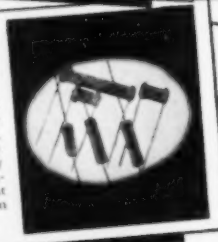
We at Chicago Transformer are proud that our product has contributed to the recognized quality and increasing popularity of Heathkits.

CHICAGO TRANSFORMER DIVISION
Essex Wire Corporation

L. S. RACINE
Vice-President and Sales Manager

HEATHKIT PRECISION RESISTORS

Where exact resistance values are required for instrument accuracy, the Heath Co. has spared no effort in supplying the finest resistors available. Precision resistors as manufactured by Continental Carbon Inc., and Wilcor Corp., meet the rigorous JAN (Joint Army-Navy) specifications and are small in size, extremely non-inductive, highly stable, have a low temperature coefficient, and can be held to great accuracy. You'll find quality components in Heathkits.



COLLEGES USE HEATHKITS

Colleges and Universities throughout the country are using Heathkits in their electrical engineering, radio, and physics laboratories — Heathkits are the answer to good test equipment at low cost, plus being rugged, dependable, and accurate. Trade schools are having their students build Heathkits to obtain a first hand working knowledge of test equipment and to get the practical experience gained by construction. Heathkits fill school needs.

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ROCKE INTERNATIONAL CORP
NEW YORK CITY

The HEATH COMPANY
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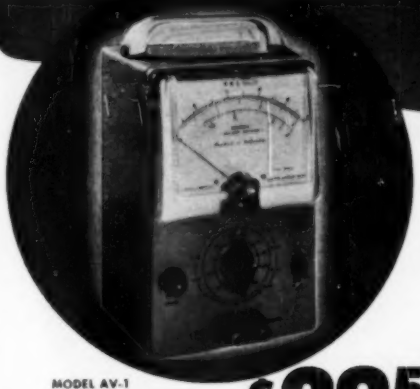
New LABORATORY LINE HEATHKITS



NEW *Heathkit*
A.C. VACUUM TUBE
VOLTMETER KIT

MODEL AV-1
Shipping weight 5 lbs.

$29.50

Now — as a Heathkit — at a price anyone can afford, an AC VTVM.
A new kit to make possible those sensitive AC measurements required by audio enthusiasts, laboratories, and experimentors. Here is the kit that the audio men have been looking for. Its tremendous range of coverage makes possible measurements of audio amplifier frequency response — gain or loss of audio stages — characteristics of audio filters and attenuators — hum investigation — and literally a multitude of others. Ten ranges consisting of full scale .01, .03, .1, .3, 1, 3, 10, 30, 100, 300 volts RMS assure easy and more accurate readings. Ten ranges on DB provide for measurements from −52 to +52 DB. Frequency response within 1 DB from 20 cycles to 50 KC.

The ingenious circuitry incorporates precision multiplier resistors for accuracy, two amplifier stages using miniature tubes, a unique bridge rectifier meter circuit, quality Simpson meter with 200 microampere movement, and a clean layout of parts for easy wiring. A high degree of inverse feedback provides for stability and linearity.

Simple operation is accomplished by the use of only one control, a range switch which changes the voltage ranges in multiples of 1 and 3, and DB ranges in steps of 10.

The instrument is extremely compact, cabinet size — 4⅛" deep x 4-11/16" wide x 7⅞" high, and the newly designed cabinet makes this the companion piece to the VTVM. For audio work, this kit is a natural.

NEW *Heathkit*
AUDIO FREQUENCY METER KIT

MODEL AF-1
Shipping weight 12 lbs.

$34.50

A NEW Heathkit Audio Frequency Meter — the ideal instrument for determining frequencies from 20 cycles to 100 KC. Set the selector switch to the proper range — feed the signal into the input terminals — and read the frequency from the meter — completely simple to operate, and yet dependable results.

Quality Simpson 200 microampere meter has two plainly marked scales (0-300 0-500. These scales, read in conjunction with the seven position selector switch, give full scale readings of 100, 300, 1000, 3000, 10,000, 30,000 and 100,000 cycles. Convenient ranges for fast and easy readings.

For greatest accuracy, the 1-3-10 ratio of ranges is maintained and each range has individual calibrating control.

Input impedance is high (1 megohm) for negligible circuit loading. A signal voltage anywhere between 2 and 300V can be fed directly into the instrument and a change in signal voltage between these limits will not affect the meter reading. In addition, input wave shape is not critical (the unit will read the frequency of either sine wave or square wave input).

The tube complement consists of a 6SJ7 amplifier and clipper, 6V6 amplifier and clipper, 6H6 meter pulse rectifier, 6X5 power supply rectifier, and OD3/VR150 voltage regulator.

Construction is simple, and quality components are used throughout.

NEW *Heathkit*
INTERMODULATION ANALYZER KIT

MODEL IM-1
Shipping wt. 18 lbs.

$39.50

Intermodulation testing of audio equipment is rapidly being accepted by more and more engineers and audio experts as the best way to determine the characteristics of audio amplifiers, recording systems, networks, etc. — shows up those undesirable characteristics which contribute to listening fatigue when all other methods fail.

The Heathkit Intermodulation Analyzer supplies a choice of two high frequencies (5000 cycles and a higher frequency) and one low frequency (60 cycles). Both 1:1 or 4:1 ratios of low to high frequencies can be set up for IM testing, and the ratios are easily set by means of a panel control and the instrument's own VTVM. An output level control supplies the mixed signal at the desired level with an output impedance of two thousand ohms. The Analyzer section has input level control and proper filter circuits feeding the instrument's VTVM to read intermodulation directly on full scale ranges of 30%, 10% and 3%. Built-in power supply furnishes all necessary voltages for operating the instrument.

You won't want to be without this new and efficient means of testing.

NEW
Heathkit SQUARE WAVE
GENERATOR KIT

MODEL SQ-1
Shipping wt. 14 lbs.

$29.50

The new Heathkit Square Wave Generator Kit with its 100 KC square wave opens an entirely new field of audio testing. Square wave testing over this wide range will quickly show high and low frequency response characteristics of circuits — permit easy adjustment of high frequency compensating networks used in vidio amplifiers — identify ringing in circuits — demonstrate transformer characteristics, etc.

The circuitry consists of a multivibrator stage, a clipping and squaring stage, and a cathode follower output stage. The power supply is transformer operated and utilizes a full wave rectifier tube with 2 sections of LC filtering.

As a multivibrator cannot be accurately calibrated, a provision is provided to allow the instrument to be accurately synchronized with an accurate external source when extreme accuracy is required.

The low impedance output is continuously variable between 0 and 25 volts and operation is simple. You'll really appreciate the wide range of this instrument, 10 cycles to 100 kilocycles — continuously variable. Kit is complete with all parts and instruction manual, and is easy to build.

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EXPORT AGENT
ROCKE INTERNATIONAL CORP
13 E. 40th ST.
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The HEATH COMPANY
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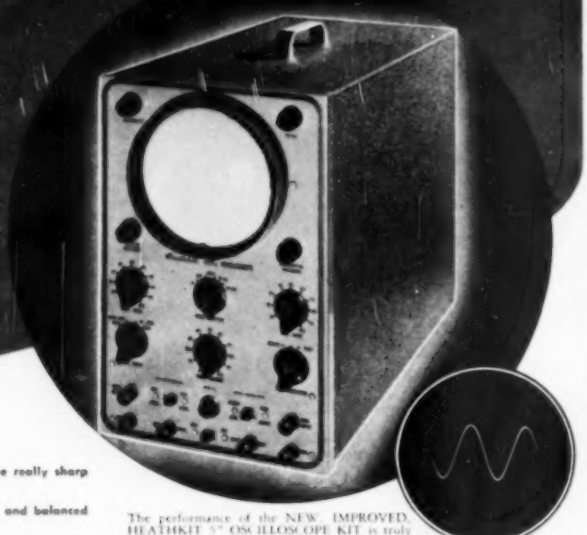
THE *New* 1952

Heathkit

OSCILLOSCOPE KIT

MODEL O-7
SHIPPING WEIGHT 24 LBS.

$43.50



Features

- New "spot shape" control for spot adjustment — to give really sharp focusing.
- A total of ten tubes including CR tube and five miniatures.
- Cascaded vertical amplifiers followed by phase splitter and balanced push-pull deflection amplifiers.
- Greatly reduced retrace time.
- Step attenuated — frequency compensated — cathode follower vertical input.
- Low impedance vertical gain control for minimum distortion.
- New mounting of phase splitter and deflection amplifier tubes near CR tube base.
- Greatly simplified wiring layout.
- Increased frequency response — useful to 5 Mc.
- Tremendous sensitivity .03V RMS per inch Vertical — 6V RMS per inch Horizontal.
- Dual control in vernier sweep frequency circuit — smoother acting.
- Positive or negative peak internal synchronization.

The performance of the NEW, IMPROVED HEATHKIT 5" OSCILLOSCOPE KIT is truly amazing. The O-7 not only compares favorably with equipment costing 4 and 5 times as much, but in many cases literally surpasses the really expensive equipment. The new, and carefully engineered circuit incorporates the best in electronic design — and a multitude of excellent features all contribute to the outstanding performance of the new scope.

The VERTICAL CHANNEL has a step attenuated, frequency compensated vertical input which feeds a cathode follower stage — this accomplishes improved frequency response, presents a high impedance input, and places the vertical gain control in a low impedance circuit for minimum distortion. Following the cathode follower stage is a twin triode — cascaded amplifiers to contribute to the scope's extremely high sensitivity. Next comes a phase splitter stage which properly drives the push-pull, hi-gain, deflection amplifiers (whose plates are directly coupled to the vertical deflection plates). This fine tube lineup and circuitry give a sensitivity of .03V per inch RMS vertical and useful frequency response to 5 Mc.

The HORIZONTAL CHANNEL consists of a triode phase splitter with a dual potentiometer (horizontal gain control) in its plate and cathode circuits for smooth, proper driving of the push-pull horizontal deflection amplifiers. As in the vertical channel, horizontal deflection amplifier plates are direct coupled to the CR tube horizontal deflection plates (for improved frequency response).

The WIDE RANGE SWEEP GENERATOR circuit incorporates a twin triode multivibrator stage for producing a good saw-tooth sweep frequency (with faster retrace time). Has both coarse and vernier sweep frequency controls.

And the scope has internal synchronization which operates on either positive or negative peaks of the input signal — both high and low voltage rectifiers — Z axis modulation (intensity modulation) — new spot shape (astigmatism) control for spot adjustment — provisions for external synchronization — vertical centering and horizontal centering controls, wide range focus control — and an intensity control for giving plenty of trace brilliance.

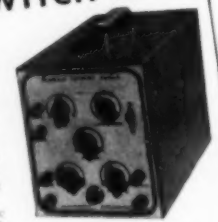
The Model O-7 EVEN HAS GREAT NEW MECHANICAL FEATURES — A special extra-wide CR tube moulting bracket is provided so that the vertical cascade amplifier, vertical phase splitter, vertical deflection amplifier, and horizontal deflection amplifier can mount near the base of the CR tube. This permits close connection between the above stages and to the deflection plates; distributed warring capacity is greatly reduced, thereby affording increased high frequency response.

The power transformer is specially designed so as to keep its electrostatic and electromagnetic fields to a minimum — also has an internal shield with external ground lead.

You'll like the complete instructions showing all details for easily building the kit — includes pictorials, step-by-step construction procedure, numerous sketches, schematic, circuit description. All necessary components included — transformer, cabinet, all tubes (including CR tube), completely punched and formed chassis—nothing else to buy.

NEW INEXPENSIVE *Heathkit*

ELECTRONIC SWITCH KIT



The companion piece to a scope — Feed two different signals into the switch, connect its output to a scope, and you can observe both signals — each as an individual trace. Gain of each input is easily set (gain A and gain B controls), the switching frequency is simple to adjust (coarse and fine frequency controls) and the traces can be superimposed for comparison or separated for individual study (position control).

Use the switch to see distortion, phase shift, clipping due to improper bias, both the input and output traces of an amplifier — as a square wave generator over limited range.

The kit is complete; all tubes, switches, cabinet, power transformer and all other parts, plus a clear detailed construction manual.

Model S-7
Shipping Wt. 11 lbs.

Only

$19.50

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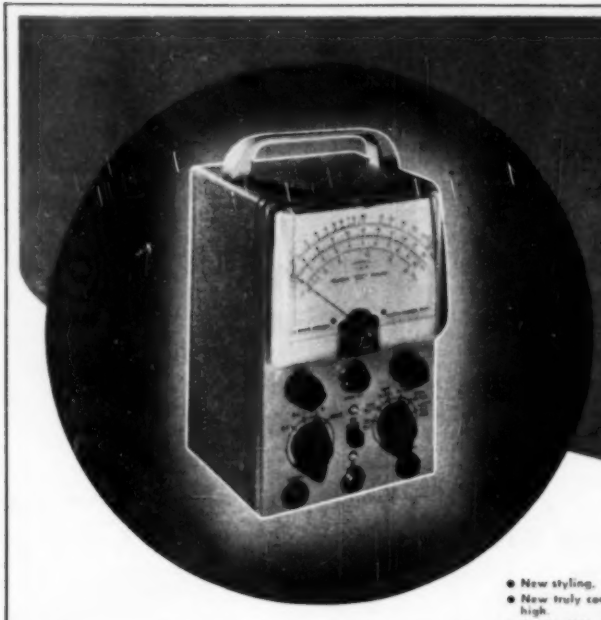
ROCKS INTERNATIONAL CORP. 15 E. 40th ST. NEW YORK CITY (16)

The HEATH COMPANY

. . . BENTON HARBOR 15, MICHIGAN



THE *New* 1952 *Heathkit* VTVM KIT

MODEL V-5
SHIPPING WT. 5 LBS.

$24.50

Features

- **New styling. — formed case for beauty.**
- **New truly compact size. Cabinet 4½" deep by 4-11/16" wide by 7⅛" high.**
- **Quality 200 microamp meter.**
- **New ohms battery holding clamp and spring clip — assurance of good electrical contact.**
- **Highest quality precision resistors in multiplier circuit.**
- **Calibrates on both AC and DC for maximum accuracy.**
- **Terrific coverage — reads from ½V to 1000V AC, ½V to 1000V DC, and .1 to over 1 billion ohms resistance.**
- **Large, clearly marked meter scales indicate ohms, AC Volts, DC Volts, and DB — has zero set mark for FM alignment.**
- **New styling presents attractive and professional appearance.**

A real beauty — you'll have only highest praise for this NEW MODEL VACUUM TUBE VOLTMETER. Truly a beautiful little instrument — and it's more compact than any of our previous models. Note the new rounded edges on the front panel and rear cover. The size is greatly reduced to occupy a minimum of space on your workbench — yet the meter remains the same large size with plainly marked scales.

A set of specially designed control mounting brackets permit calibration to be performed with greatest ease — also makes for ease in wiring. New battery mounting clamp holds ohms battery tightly into place, and base spring clip insures a good connection to the ohms string of resistors.

The circuitry employs two vacuum tubes — A duo diode operating when AC voltage measurements are taken, and a twin triode in the circuit at all times. The cathode balancing circuit of the twin triode assures sensitive measurements, and set offers complete protection to the meter movement. Makes the meter burn-out proof in a properly constructed instrument.

Quality components are used throughout — 1% precision resistors in the multiplier circuit — conservatively rated power transformer — Simpson meter movement — excellent positive detent, smooth acting switches — sturdy cabinet, etc.

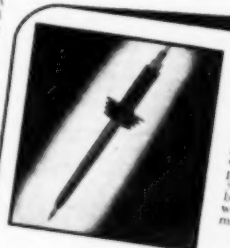
And you can make a tremendous range of measurements — ½V to 1000V AC, ½V to 1000V DC, .1 to over 1 billion ohms, and DB. Has mid-scale zero level marking for quick FM alignment. DB scale in red for easy identification — all other scales a sharp, crisp black for for easy reading.

A four position selector switch allows operator to rapidly set the instrument for type of reading desired — positions include AC V, DC + V, DC − V, and Ohms. DC — position allows negative voltage to be rapidly taken. Zero adjust and ohms adjust controls are conveniently located on front panel.

Enjoy the numerous advantages of using a VTVM. Its high input impedance doesn't "load" circuits under test — therefore, assures more accurate and dependable readings in high impedance circuits such as resistance coupled amplifiers, AVC circuits, etc. Note the 30,000 VDC probe kit and the RF probe kit — available at low extra cost and specially designed for use with this instrument. With these two probes, you can make DC voltage measurements up to 30,000V, or make RF measurements — added usefulness to an already highly useful instrument.

The instruction manual is absolutely complete — contains a host of figures, pictorials, schematic, detailed step-by-step instructions, and circuit description. These clear, detailed instructions make assembly a cinch.

And every part is included — meter, all controls, pilot light, switches, test leads, cabinet, instruction manual, etc.



Heathkit 30,000V DC
PROBE KIT

A new 30,000 V DC Probe Kit to handle high voltages with safety. For TV service work and all other high voltage applications. Sleek looking — Two color molded plastic — Red body and guard — jet black handle. Comes with connector, cable, and PL55 type plug. Plugs into Heathkit VTVM so that 500V scale is conveniently multiplied by 100. Can be used with any standard 11 megohm VTVM.

$5.50

No. 336 High Voltage Probe Kit
Shipping Wt. 2 lbs.

Heathkit
RF PROBE KIT

This RF Probe Kit comes complete with probe housing, crystal diode detector, connector, lead and plug and all other parts plus clear assembly instructions. Extends range of Heathkit VTVM to 250 Mc. ± 10%. Works on any 11 megohm input VTVM. Specify No. 309 RF Probe Kit.

$5.50

Ship. Wt. 1 lb.

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ROCKE INTERNATIONAL CORP
NEW YORK CITY

The HEATH COMPANY
. . . BENTON HARBOR 15, MICHIGAN

Heathkit

SIGNAL GENERATOR KIT

Model SG-6
Shipping Wt. 7 lbs.

$19.50

The new Heathkit Signal Generator Kit has dozens of improvements. Covers the extended range of 160 Kc to 50 megacycles on fundamentals and up to 150 megacycles on useful calibrated harmonics; makes this Heathkit ideal as a marker oscillator for TV. Output level can be conveniently set by means of both step attenuator and continuously variable output controls. Instrument has new miniature HF tubes to easily handle the high frequencies covered.

Uses 6C4 master oscillator and 6C4 sine wave audio oscillator. The kit is transformer operated and a husky selenium rectifier is used in the power supply. All coils are precision wound and checked for calibration making only one adjustment necessary for all bands.

New sine wave audio oscillator provides internal modulation and is also available for external audio testing. Switch provided allows the oscillator to be modulated by an external audio oscillator for fidelity testing of receivers. Comes complete, all tubes, cabinet, test leads, every part. The instruction manual has step-by-step instructions and pictorials. It's easy and fun to build a Heathkit Model SG-6 Signal Generator.

Heathkit

CONDENSER CHECKER KIT

Only

$19.50

Model C-2
Shipping Wt. 6 lbs.

Checks all types of condensers — paper — mica — ceramic — electrolytic. All condensers are direct reading and require no charts or multipliers. Covers range of .00001 MFD to 1000 MFD. A Condenser Checker that anyone can read. A leakage test and polarizing voltage for 20 to 500 V. provided. Measures power factor of electrolytics between 0% and 50% and reads resistance from 100 ohms to 5 megohms. The magic eye indicator makes testing easy.

The kit is 110V 60 cycle transformer operated and comes complete with rectifier tube, magic eye tube, cabinet, calibrated panel and all other parts. Has clear detailed instructions for assembly and use.

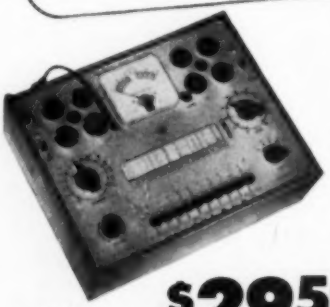
NEW *Heathkit*

SIGNAL TRACER AND UNIVERSAL TEST SPEAKER KIT

$19.50

Model T-2
Shipping Wt. 7 lbs.

The popular Heathkit Signal Tracer has now been combined with a universal test speaker at no increase in price. The same high quality tracer follows signal from antenna to speaker — locates intermittents — finds defective parts quicker — saves valuable service time — gives greater income per service hour. Works equally well on broadcast, FM, or TV receivers. The test speaker has an assortment of switching ranges to match either push-pull or single output impedances. Also tests microphones, pickups and PA systems. Comes complete: cabinet, 110V 60 cycle power transformer, tubes, test probe, all necessary parts, and detailed instructions for assembly and use.



Model TC-1
Shipping Wt. 12 lbs.

$29.50

Heathkit

TUBE CHECKER KIT

The Tube Checker is a MUST for radio repair men. Often customers want to SEE tubes checked, and a checker like this builds customer confidence. In your repairing, you will have a multitude of tubes to check — quickly. The Heathkit tube checker will serve all these functions — it's good looking (with a polished birch cabinet and an attractive two color panel) — checks 4, 5, 6, 7 prong Octals, Loctals, 7 prong miniatures, 9 prong miniatures, pilot lights, and the Hytron 5 prong types. AND IT'S FAST TO OPERATE — the gear driven, free-running roll chart lists hundreds of tubes, and the smooth acting, simplified switching arrangement gives really rapid set-ups.

The testing arrangement is designed so that you will be able to test new tubes of the future — without even waiting for factory data — protection against obsolescence.

You can give tubes a thorough testing — checks for opens, shorts, each element individually, emission, and for filament continuity. A large BAD-?-GOOD meter scale is in three colors for easy reading and also has a "line-set" mark.

You'll find this tube checker kit a good investment — and it's only $29.50.

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ROCKE INTERNATIONAL CORP
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The HEATH COMPANY
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NEW 1952 *Heathkit*

BATTERY ELIMINATOR KIT

$24.50

Model BE-3
Shipping Wt. 17 lbs.

- **Can be used as battery charger.**
- **Continuously variable output 0 - 8 Volts — not switch type.**
- **Heavy duty Mallory 17 disk type magnesium copper sulfide rectifier.**
- **Automatic overload relay for maximum protection. Self-resetting type.**
- **Ideal for battery, aircraft and marine radios.**
- **Dual Volt and Ammeters read both voltage and amperage continually — no switching.**

The new Heathkit Model BE-2 incorporates the best. Continuously variable output control is of the variable transformer type with smooth wiper type contacts.

There are no switches or steps and voltage between 0 and 8 Volts is available at 10 Amperes continuous and 15 Amperes intermittent. Maximum safety from overloads and shorts provided by automatic overload relay which resets itself when overload is removed.

The new rectifier is a 17 plate Mallory magnesium copper sulfide type. This is th, most rugged type available for long trouble-free use.

Output is continuously metered by both a 0 - 10 Volt Voltmeter and a 0 - 15 Amp Ammeter. Shorted vibrators indicated instantly by ammeter.

Equip now for all types of service — aircraft — marine — auto and battery radios — this inexpensive instrument vastly increases service possibilities — better be ready when the customer walks in.

NEW *Heathkit*

SINE AND SQUARE WAVE AUDIO GENERATOR KIT

Designed with versatility, usefulness, and dependability in mind, the AG-7 gives you the two most needed wave shapes right at your fingertips — the sine wave and the square wave.

The range switch and plainly calibrated frequency scale give rapid and easy frequency selection, and the output control permits setting the output to any desired level.

A high-low impedance switch sets the instrument for either high or low impedance output —on high to connect a high impedance load, and on low to work into a low impedance transformer with negligible DC resistance.

Coverage is from 20 to 20,000 cycles, and distortion is at a minimum — you can really trust the output wave shape.

Six tubes, quality 4 gang tuning condenser, power transformer, metal cased filter condenser, 1% precision resistors in the frequency determining circuit, and all other parts come with the kit —plus, a complete construction manual — A tremendous kit, and the price is truly low.

Model AG-7
Shipping Wt. 15 lbs.

$34.50

THE NEW *Heathkit*

HANDITESTER KIT

A precision portable volt-ohm milliammeter. Uses only high quality parts — All precision 1% resistors, three deck switch for trouble-free mounting of parts, specially designed battery mounting bracket, smooth acting ohm adjust control, beautiful molded bakelite case, 400 micro-amp meter movement, etc.

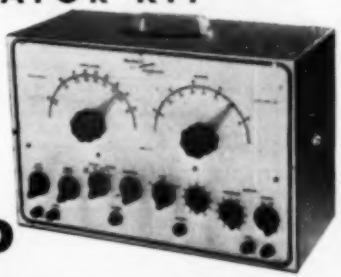
DC and AC voltage ranges 10 - 30 - 300 - 1000 - 5000V. Ohms range 0 - 3000 and 0 - 300,000. Range Milliamperes 0 - 10 Ma, 0 - 100 Ma. Easily assembled from complete instructions and pictorial diagrams.

$13.50

Model M-1
Shipping Wt. 3 lbs.

NEW *Heathkit*

T.V. ALIGNMENT GENERATOR KIT



Here is an excellent TV Alignment Generator designed to do TV service work quickly, easily, and properly. The Model TS-2 when used in conjunction with an oscilloscope provides a means of correctly aligning television receivers.

The instrument provides a frequency modulated signal covering, in two bands, the range of 10 to 90 Mc. and 150 to 230 Mc — ALL ALLOCATED TV CHANNELS AS WELL AS IF FREQUENCIES ARE COVERED.

An absorption type frequency marker covers from 20 to 75 Mc. in two ranges—therefore, you have a simple, convenient means of frequency checking of IF's, independent of oscillator calibration.

Sweep width is controlled from the front panel and covers a sweep deviation of 0-12 Mc.—all the sweep you could possibly need or want.

And still other excellent features are: Horizontal sweep voltage available at the front panel and controlled with a phasing control—both step and continuously variable attenuation for setting the output signal to the desired level—a convenient instrument stand-by position—vernier drive of both oscillator and marker tuning condensers—and blanking for establishing a single trace with base reference level. Make your work easier, save time, and repair with confidence—order your Heathkit TV Alignment Generator now!

Model TS-2
Shipping Wt. 20 lbs.

$39.50

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131 Varick St.
NEW YORK CITY (13)

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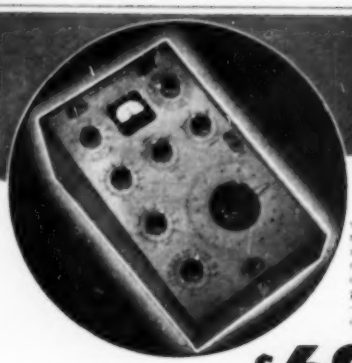


Heathkit
IMPEDANCE BRIDGE KIT

Model IB-1B
Shipping Wt. 15 lbs.

$69.50

This Impedance Bridge Kit is really a favorite with schools, industrial laboratories, and serious experimenters. An invaluable instrument for those doing electrical measurements work. Reads resistance from .01 Ohms to 10 meg., capacitance from 100PF to 100 MFD, inductance from 10 microhenries to 100 henries, dissipation factor from .002 to 1, and storage factor from 1 to 1000. And you don't have to worry about selecting the proper bridge circuit for the various measurements — the instrument automatically makes the correct circuit when you set up for taking the measurement you want. Bridge utilizes Wheatstone, Hay, Maxwell, and capacitance comparison circuits for the wide range and types of measurements possible. And it's self powered — has internal battery and 1000 cycle hummer. No external generator required — has provisions for external generator if measurements at other than 1000 cycles are desired. Kit utilizes only highest quality parts. General Radio main calibrated control. Mallory ceramic switches, excellent 200 microamp zero center galvanometer, laboratory type binding posts with standard ¾ inch centers, 1% precision ceramic-body type multiplier resistors, beautiful birch cabinet and ready calibrated panel. (Headphones not included.)

Take the guesswork out of electrical measurements — order your Heathkit Impedance Bridge kit today — you'll like it.

Heathkit LABORATORY
RESISTANCE DECADE KIT

$19.50
Shipping Wt. 4 lbs.

An indispensable piece of laboratory equipment — the Heathkit Resistance Decade Kit gives you resistance settings from 1 to 99,999 ohms IN ONE OHM STEPS. For greatest accuracy, 1% precision ceramic-body type resistors and highest quality ceramic wafer switches are used.

Designed to match the Impedance Bridge above, the Resistance Decade Kit has a beautiful birch cabinet and attractive panel. It's easy to build, and comes complete with all parts and construction manual.

Heathkit LABORATORY
POWER SUPPLY KITS

Limits:

No load	Variable	150-400V DC
25 MA	Variable	30-310V DC
50 MA	Variable	25-250V DC

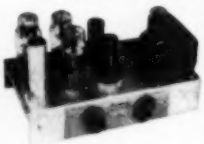
Higher loads: Voltage drops off proportionally

Every experimenter needs a good power supply for electronic setups of all kinds. This unit has been expressly designed to act as a HV supply and a 6.3 V. filament voltage source. Voltage control allows selection of HV output desired (continuously variable within limits outlined), and a Volts-Ma switch provides choice of output metering. A large plainly marked and direct reading meter scale indicates either DC voltage output in Volts or DC current output in Ma. (Range of meter 0-500V D.C., 0-200 Ma. D.C.). Instrument has convenient stand-by position and pilot light.

$29.50
Model PS-1 Ship. Wt. 20 lbs.

Comes with power transformer, filament transformer, meter, 5Y3 rectifier, two 1619 control tubes, completely punched and formed chassis, panel, cabinet, detailed construction manual, and all other parts to make the kit complete.

Heathkit
ECONOMY . . . 6 WATT
AMPLIFIER KIT

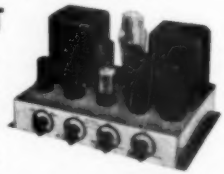


Model A-4
Ship. Wt. 8 lbs.

$12.50
No. 304-12 inch speaker . . . **$6.95**

This fine Heathkit Amplifier was designed to give quality reproduction and yet remain low in price. Has two preamp stages, phase inverter stage, and push-pull beam power output. Comes complete with six tubes, quality output transformer (to 3-4 ohm voice coil), husky cased power transformer and all other parts. Has tone and volume controls. Instruction manual has pictorial for easy assembly. Six watts output with response flat ± 1½ db from 50 to 15,000 cycles. A quality amplifier kit at a low price. Better build one.

Heathkit HIGH FIDELITY . . . 20 WATT
AMPLIFIER KIT



$33.50
Shipping Wt. 18 lbs.

Our latest and finest amplifier — the model A-6 (or A-6A) is capable of a full 20 Watts of high fidelity output — good faithful reproduction made possible through careful circuit design and the use of only highest quality components. Frequency response within ± 1 db from 20-20,000 cycles. Distortion at 5 db below maximum power output (at 1000 cycles) is only 8%. The power transformer is rugged and conservatively rated and will deliver full plate and filament supply with ease. The output transformer was selected because of its exceptionally good frequency response and wide range of output impedances (4-8-16-150-600 ohms). Both are Chicago Transformers in drawn steel case for shielding and maximum protection to windings. The unit has dual tone controls to set the output for the tonal quality desired — treble control attenuates up to 15 db at 10,000 cycles — bass control gives bass boost up to 10 db at 50 cycles.

Tube complement consists of 5U4G rectifier, 6SJ7 voltage amplifier, 6SN7 amplifier and phase splitter, and two 6L6's in push-pull output. Comes complete with all parts and detailed construction manual. (Speaker not included.)

MODEL A-6: For tuner and crystal phono inputs. Has two position selector switch for convenient switching to type of input desired.

MODEL A-6A: Features an added 6SJ7 stage (preamplifier) for operating from variable reluctance cartridge phono pickup, mike input, and either tuner or standard crystal phono pickup. A three position selector switch provides flexible switching.
Shipping Wt. 18 lbs. **$35.50**

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The HEATH COMPANY
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Heathkit RECEIVER & TUNER KITS for AM and FM

$19.50

Model BR-1 Broadcast Model Kit covers 550 to 1600 Kc. Shipping Wt. 10 lbs.

Model AR-1 3 Band Receiver Kit covers 550 Kc. to over 20 Mc. continuous. Extremely high sensitivity. Shipping Wt. 10 lbs.

$23.50

TWO HIGH QUALITY *Heathkit* SUPERHETERODYNE RECEIVER KITS

Two excellent Heathkits. Ideal for schools, replacement of worn out receivers, amateur and custom installations.

Both are transformer operated quality units. The best of materials used throughout — six inch calibrated slide rule dial — quality power output transformers — dual iron core shielded, I.F. coils — metal cased filter condenser. The chassis has phono input jacks, 110 Volt output for phono motor and there is a phono-radio switch on panel. A large metal panel simplifying installation in used console cabinets is included. Comes complete with tubes and instruction manual incorporating pictorials and step-by-step instructions (less speaker and cabinet). The three band model has simple coil turret which is assembled separately for ease of construction.

Model FM-2
Ship. Wt. 9 lbs.

$22.50

TRUE FM FROM *Heathkit* FM TUNER KIT

The Heathkit FM Tuner Model FM-2 was designed for best tonal reproduction. The circuit incorporates the most desirable FM features — true FM.

Utilizes 8 tubes: 7E5 Oscillator, 6SH7 mixer, two 6SH7 IF amplifiers, 6SH7 limiter, two 7C4 diodes as discriminator, and 6X5 rectifier.

The instrument is transformer operated making it safe for connection to any type receiver or amplifier. Has ready wound and adjusted RF coils, and 2 stages of 10.7 Mc IF (including limiter). A calibrated six inch slide rule dial has vernier drive for easy tuning. All parts and complete construction manual furnished.

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BENTON HARBOR 15,
MICHIGAN

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	Heathkit VTVM Kit — Model V-5			Heathkit R.F. Signal Gen. Kit — Model SG-6	
	Heathkit FM Tuner Kit — FM-2			Heathkit Condenser Checker Kit — Model C-2	
	Heathkit Broadcast Receiver Kit — Model BR-1			Heathkit Handitester Kit — Model M-1	
	Heathkit Three Band Receiver Kit—Model AR-1			Heathkit Power Supply Kit — Model PS-1	
	Heathkit Amplifier Kit — Model A-4			Heathkit Resistance Decade Kit — Model RD-1	
	Heathkit Amplifier Kit — Model A-6 (or A-6A)			Heathkit Impedance Bridge Kit — Model IB-1B	
	Heathkit Tube Checker Kit — Model TC-1			Heathkit A.C. VTVM-KIT — Model AV-1	
	Heathkit Audio Generator Kit — Model AG-7			Heathkit Intermodul. Analyzer Kit—Model IM-1	
	Heathkit Battery Eliminator Kit — Model BE-2			Heathkit Audio Freq. Meter Kit — Model AF-1	
	Heathkit Electronic Switch Kit — Model S-2			Heathkit Square Wave Gen. Kit — Model SQ-1	
	Heathkit T.V. Alignment Gen. Kit — TS-2				
	Heathkit Signal Tracer Kit — Model T-2				
	Heathkit R.F. Probe Kit — No. 309				

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BUILT-IN HOME TV SYSTEMS

By
IRA KAMEN
Director of Sales
Brach Manufacturing Corp.

The steady increase in multi-set homes provides a new market for TV technicians.

Fig. 1. Over-all view of the "Mul-Tel" unit which is designed to provide multiple outlets for single family dwellings. The box is placed out of sight near the antenna.

NOW that more and more families are keeping their small-screen television receivers as a second set, a new and profitable market has opened up for the technician.

The development of a small, home-sized master television and FM antenna system is expected to further stimulate consumer interest in retaining or purchasing a second receiver. Designed to be installed during the construction of a new dwelling or added to older structures, this unit provides four antenna outlets in the house, their locations being a matter of choice at the time of installation. Since the system also carries FM signals one of the outlets can be used in the room in which an FM receiver is to be connected. All wiring is within the walls, the only visible evidence being the receptacle plate which appears on the wall at each of the four outlets. One such unit is shown in Fig. 2.

The key to this new system is the four-set coupler developed and produced by *Brach Manufacturing Corporation*. This simple device, shown in Fig. 1, is connected to any good antenna with a 300 ohm, ribbon-type transmission line. Four receptacles are provided at the bottom of the box's panel to accommodate four coaxial connectors, from which four coaxial lines run to the outlet locations.

The four outlets provide signals which are only 6 db lower than the signal from the antenna itself as the four-set coupler divides the antenna signal into four equal parts. None of the signal is dissipated in a dummy load, as is the case in resistor systems,

Fig. 2. Close-up of the receptacle which is the only part of system visible in room.

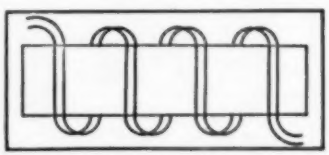
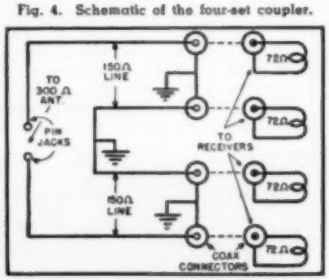


Fig. 3. How transmission lines are set up as bifilar windings around a coil form.

Fig. 4. Schematic of the four-set coupler.



"Communications"

DYNAMOTORS

Type	Input Volts	Input Amps.	Output Volts	Output Amps.	Radio Set
PE94	28	1 23	250	060	RC 36
DM41G	14	6 2	330	170	RC 19
DM33A	28	7	500	250	RC 45
PE101C	13, 26	12 6	800	135	SCR 515
		6 3	800	020	
BD AR 93	28	3 25	375	150	
23350	27	1 75	285	075	APN-1
23C0458	28	2	500	060	
ZA-085	12-24	4-2	500	050	
ZA-056	12-24	8 4	12,275	3/110	
B-19 pack	12	9 4	275	110	Mark II
			500	060	
D-384	12		225	100	
			440	200	
BA-1A	28	10	300	050	SCR 522
			150	010	
			14.5	5	
1853	28	1 4	250	060	APN-1
PE73CM	28	19	1000	350	BC 375
CW21AAX	13	12 6	400	135	
	26	6 3	800	020	
		0	1 12		
PE94	28	10	300	200	SCR
			150	010	522
			14.5	5	

SPECIAL CONVERTER
IN: 115VDC, OUT 12/26VDC, 500W
BRAND NEW **$99.50**

INVERTERS

PE 218-E: Input: 25 28 vdc 92 amp. Output: 115 v. 350-900 cy. 1,000 volt-amperes. Dim: 17"x6½"x10". New (as shown) **$49.50**

PE 218-H: Same as above except size: 16½" x 6" x 10" New **$49.50**

PE 78S: Input: 28 vdc, 38 amps. Output: 80 v. 800 cy. 500 volt-amps. Dim: 13" x 5½" x 10½". New **$22.50**

SAVE THAT FINAL!!!

Variable overload protection with this new device. Continuously variable from 30 MA thru 250 MA, with dial marked at following points:

30-35-40-45-50-60-75-100-150-200 MA

Other intermediate points may easily be marked on polished dial. Husky Relay has DPST contacts that will handle 10 amps. May be used for grid-drive protection as well as in B-minus lead of HV supply, only 20V drop. Completely encased in metal case, designed for free use mounting. Size 5½" H x 3½" W x 2½" D. Manufactured by Westinghouse and G. E. Thyrite protection. Brand new in original cartons. While they Last! **$3.95**

MOBILE CIRCUIT PROTECTOR
Kluxon Type PM—opens at 35A Thermal overload—won't pop off when starting. Miniature—easy Mtg. ea. **$0.69**

LINE FILTERS

LINE FILTER. GE 100 Amp Filter w/2x5Mfd 50V oil cond. Operates on 110VAC DC **$1.39**

1KW LINE FILTER, clean up BCI & TVI. Easy to Mount **$3.95**

Noise Filter. Jx51E. 10 Amp **$1.29**

Noise Filt. Jx55D. 4 Amp **35c**

932 PHOTO TUBE

Gas Phototube having 51 response, particularly sensitive to Red and Near Infrared Radiation. Can be used with incandescent light source. Send for Data. Price **75c**

OIL CONDENSERS

Mfd.	Volt.	Price
.5	50	$0.45
650	85	1.95
15	220AC	2.20
0.5	1000	.69
2x0.5	1000	.70
1	1000	.75
1.5	1000	.85
2	1000	.90
3x.01	1200	1.35
1	1500	1.30
1.5	1500	1.40
2	1500	1.45
2x0.1	2000	1.10
2x0.1	4000	1.20
0.1	6000	1.39
2x0.1	7000	1.75
0.1	7500	1.25
2x0.15	8000	4.75
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.0016	15000	5.95
.25	20000	
1	25000	
.5	25000	
1	7500	

INERTEEN PRE-CIPITRON CAPACITOR TYPE FL
2x0.135 @ 7500V **$12.95**

SILVER MICA BUTTONS

MMF.	MMF.	MMF.
40	175	500
50	180	
100	185	

$7.50 PER 100

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TS 102/AP
TS 62/AP
TS 36/AP
TS 12/UNIT 2
TS 49/AP
TS 33/AP
CW60-ABM
LU-1
LU-3
TS 159
TS 226
TS 250/APN
TS 89
I-201-A
TS 11/AP
BC 436
CS60-ABW
I-158
I-222
I-185
TS 268/U

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MANY OTHERS

B-19 MK11 TRANSRECEIVER
Less Power Pack **$32.50**
B-19 Power Pack **$.95**

ID-24 ARN-9
Dual 0-200 Microamp. Movement in 3" Case. ILS Equipment **$8.95**

ARC5 MODULATOR
MD7/ARC5 Plate Modulator w/dynamotor complete w/Tubes 1—12J5, 2—1625, 1—VR30. Good cond.
Price **$7.95**

TRANSFORMERS ALL PRIMARIES 115V, 60 CYCLE

COMBINATION TRANSFORMERS

Stock No.	Rating		Price
CT-77B	5500V	.002	2.5V/2A, 12KV TEST, 6.3VCT/6A, 4600V TEST	$12.95
CT-75B	1200VCT	600MA	2X5VCT/6.2A, 6.3VCT/3A, 6.3V/3A	$4.95
CT-J5-2	600VCT	200MA	5V/6A	4.95
CT-825	360VCT	340	6.3VCT/3.6, 6.3VCT/3A	3.95
CT-626	1500V	160	2.5/12, 30, 100	9.95
CT-15A	350VCT	070	6.3, 6.6,2/1.8,3Dbs.	2.95
CT-071	110V	200	33/200, 5V/10, 2.5/10	4.95
CT-378	2300V	4MA	2.5/2	6.95
CT-367	580VCT	030	5VCT/3A	2.25
CT-721	550VCT	100	6.3/1, 2.5VCT/2	2.95
CT-99A	2x110VCT	010	6.3/1A, 2.5VCT/7A	3.25
CT-401	350VCT	026MA	5V/3A	2.75
CT-610	1250	002MA	2.5V/.2 1A, 2.5V/1.75A	4.95
CT-137	330VCT	026MA	5V/3A	2.75
CT-456	300VCT	30MA	6.3V/1.3A, 5V/3A	3.45
CT-160	800VCT	100MA	6.3V/1.2A, 5V/3A	4.95
CT-319	660VCT	085A	5V/2A, 6.3/7.5A, 6.3/3A	3.25
CT-931	585VCT	85MA	5V/3A, 6.3V/6A	4.95
CT-445	50-46V	200MA	110VCT/2A,	2.75
CT-442	525VCT	75MA	5V/2A, 10VCT/2A, 50V/200MA	3.85

KLYSTRON TRANSFORMER
PRI: 115V, 60 CY.
SEC: 1050V/10MA, MINUS 625V/5MA, 26.3V/4.5MA, 2x2.5V/3A, 6.3V/3A
Stock No. CT-341. Only a few left at **$22.45**

FILAMENT TRANSFORMERS

Stock	Rating	Price
FT-184	6V/5A	$ 4.78
FT-924	5.25V/21A, 2x7.75V/6.5A, 2x26V/2.5A	17.95
FT-824	16V/1A, 7.2V/7A, 6.4V/10A, 6.4V/2A, 2x26V/2.5A	12.95
FT-357	9VCT/45A	14.75
FT-781	800 Trans. 2x2.5/3A	2.25
FT-674	8.1V/1.5A	1.10
FT-157	4V/16A, 2.5V/1.75A	2.95
FT-191	6V, 2.5A	.79
FT-55-2	7.2V,21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-986	16V @ 4.5A or 12V @ 4.5A	3.75
FT-18A	6.3/2.5A, 2x2.5V/7A	4.19
FT-A27	2.5V/2.5A, 7V/7A, TAP 2.5V/2.5A, 16KV TEST	18.95
FT-140	2x2.5V/3A, 7V/7A—23KV TEST.	24.95
FT-833	6.3V/500A, W/ELM	29.45
FT-364	6.3V/2A, 6.3V/4.5A	2.29

PLATE TRANSFORMERS

Item	Rating	Each
PT-614	4730VCT/580MA, 12KV INS	$29.95
PT-976	Auto: 120VCT/10MA	.69
PT-31A	2 x 300V/75MA	.79
PT-033	4150V/400 MA 11½ x 9¼ W x 9" D 70 lbs.	49.95
PT-481	Auto: 70V/1A	2.29
PT-368	1120VCT/770 MA, 590VCT/82 MA, 25 lbs.	24.95
PT-179	Auto: 156/146/137/128—71A	2.29
PT-31A	2 x 300V 5 MA	.79
PT-976	120VCT/10MA	.79
PT-12A	280VCT/1.2A	2.95
PT-919	1200-0-1200/200 MA	8.95

SPECIAL FIL. TRANSFORMERS

Item	Pri.	Output	Price
STF-946	210/220/230	2.5V/6A, 3½" H x 2¼" x 2¼" D	$ 1.29
STF-618	230	5V/9A, 5½" H x 4½" x 3"	1.25
STF-682	220	30-25-20V/1 MA	.69
STF-968	230	2.5V/6.5A	1.10
STF-695	230/115	5V/12/9A	2.95
STF-370	22/440	3 x 2.5V/7.5A, 2.5V/15A	5.25
STF-619	11/220	5½ x 5 x 4½ 2.5V/500A, 7 x 5½ x 5.	19.95
STF-11A	220	2 x 40V/.05/2 x 5V/6A, 12.6/1A	2.95
STF-631	230	2 x 5V/27A 2 x 5V/9A, 103/4H x 5 x 7 30 lbs.	24.95
STF-370	220/440V	3 x 2.5V/7.5A, 2.5V/15A.	9.95
STF-695	220/440V	2.5V/60 ACT	15.95
STF-883	220/440V	5VCT/30A,3000VTEST	17.50

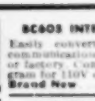
VARISTORS

D-167176	$0.95
D-172155	2.25
D-172307	1.75
D-167208E	1.85
D-168687	.95
D-171812	.95
D-171329	.95
D-162256 (300A)	1.50

THERMISTORS

D-166288	$1.50
D-167332 (tube)	1.50
D-170396 (bead)	1.50
D-167613 (button)	1.50
D-164699 for MTG	

"X" band Guide 2.50



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Easily converted to an ideal intercommunication set for office—home or factory. Complete w conversion diagram for 110V operation.
Brand New **$4.75**

UNIVERSAL POWER TRANSFORMER
Pri: Vibrator Input 6 6/12, 24, 110VDC
AC Input: 110, 220V, 6, 60 CY
Sec: 230-0-230V — 40MA, 6.3V — 1.8A
Ea. **$1.49**

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A NATURAL FOR THAT NEW 2—40ft.—3 ELEMENT PLUMBERS DELIGHT 8 FT. LONG, OF TUBULAR STEEL CONSTRUCTION. END BRACKETS FOR MOUNTING ELEMENTS. MAST MTG CUP 3" DIAMETER. ONLY 20 LBS., NET WT.
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RADAR	—	RADIO	—	SONAR
APS-2		APN-4		QBF
APS-4		SCR-518		QBG
APS-10		SCR-545		QCJ
APS-15		FDMK-4		QCL
SA-3C-3N		MK-10		QCO

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UP TO 18 VAC IN— UP TO 14 VDC OUT

2A	$ 2.50
4A	4.00
6A	5.00
10A	7.50
12A	9.00
24A	15.00

UP TO 36 VAC IN— UP TO 28 VDC OUT

1A	$ 2.50
2A	4.00
4A	8.00
10A	14.50
12A	18.00
24A	36.00

UP TO 54 VAC IN UP TO 42 VDC OUT

2A	$8.50
4A	8.50

UP TO 120 VAC IN UP TO 106 VDC OUT

2A	$11.00
4A	48.00
12A	60.00

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HI-Current Chokes
1 HY—12 Amp—46 Ohms **$14.95**
01 HY—2.5 Amp—Cased **$2.25**

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Primaries 115v, 50 Cycle
36V-40V at 3.5 amps. **$3.75**
24v-1.5A **1.95**
8V-1.5A **.95**
16v-3A **3.75**
12v-3A **3.75**

PRECISION RESISTORS

OHMS	OHMS	OHMS
5	150	7,500
5.05	25+	10,000
10	430	12,000
18	468	17,000
12	800	20,000
120	920	30,000
125	1100	35,000
128	4300	84,000

30c EACH 10 FOR $2.50
100K 150K 150K 220K
40c EACH 10 FOR $3.50
1 MEGOHM EACH 75c

HI-FI UNIVERSAL OUTPUT TRANSFORMER

American Silcor. PRI: 20,000/16,000/5000/4000 ohms. Sect. 500/15/7.5/5/3.75/1.25 ohms 30 db. contin. Flat to 20,000 CY. w/Diag **$4.75**

AUDIO TRANSFORMERS

AT501 HI-FI Special: PRI: 3000 ohms P-P/sec. 4/16/12/50/200 ohms 60-10,000 CY —1 db 50W as shown **$3.49**

AT152 HI-FI Driver Pri: 10,000 ohms Sec: 40,000 ohms PP Grids 50-15 KC/1 db. **$1.49**

AT063 Output to H.S. or line PRI: 14,200 ohms SEC: 4000-500 ohms **$1.19**

AT449 HI-FI Driver (5000 ohms) to P.P. output grids (4,000 ohms) 100-10,000 CY. 10 W. 6V6 to PP 6005s **$2.39**

AT656 Intercom Input: Spkr (4-8 ohms) to grid (250,000 ohms) **$0.69**

AT425 Plate (18,000 ohms C.T.) to line (125 ohms) 175 w —500-600 CY. **$1.95**

AT858 Plate (10,000 ohms C.T.) to line V.C. (500/125/30 ohms) HI-FI—50 W. **$6.95**

AT070 Mike-or-Line (250 ohms) to grid (250,000 ohms C.T.) **$1.29**

AT765 Mike-or-Line (600 ohms) to grid (50,000 ohms C.T.) **$0.89**

FILTER CHOKES

Stock	Description	Price
CH-250	SWING 2.5-24H/4-05A 10KV Test	$7.95
CH-19	SWING .006H-5A-935H/.5A .032 ohms DCR, 1KV TEST	3.95
CH-776	1.28 H/130 MA/75 ohms	2.25
CH-344	1.5 H/145 MA/1200V Test	2.39
CH-854	1 HY/80 MA	1.95
CH-88A	10 HY/12 MA—850 ohms DCR	1.75
CH-999	15 HY/15 MA—400 ohms DCR	1.95
CH-511	6 H./80 MA—310 ohms DCR	2.45
CH-503	2x.5H/400 MA	2.79
CH-188M	5 HY 200 MA	1.79
CH-488	10 HY .030A	1.19
CH-795	Dual 1.75-125 HY 100 MA	3.27
CH-88C	Dual 01-3.5 HY 950-75 MA	3.10
CH-981	15 HY 110A	1.59
CH-22-1	1 HY 100A	1.27
CH-879	6 HY 400A	3.25
CH-25A	SW .09/.018 HY 3/.3A	0.95
CH-922	10000 HY 0 MA	2.75
CH-043	2.2 HY 80 MA	.98

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since the coupler employs transmission-line techniques.

The four-set coupler contains two transmission lines, each of 150 ohms characteristic impedance. The circuit of this unit is shown schematically in Fig. 4. At the input end, the lines are in series with the center of the system, grounded for balance. The two 150 ohm lines, with input ends in series, constitute a 300 ohm impedance to match the 300 ohm antenna transmission line to which the input is connected.

The output end of each line has, of course, an impedance of 150 ohms. Across this impedance two 75 ohm (nominally 72 ohm) receiver inputs are connected in series, thus terminating each line in its characteristic impedance to prevent reflections. It is not necessary to have the receiver inputs facing an impedance of the "correct" value, since this does not cause reflections and the only result of the method used is to divide the energy appearing at the output end of each line in two, accounting for the 6 db signal loss in the forward direction between antenna and any receiver. If fewer than four receivers are used, the unused outlets should be terminated with a dummy load resistor. These are supplied with each coupler in the form of three dummy coaxial plugs with built-in resistors.

There were two major problems involved in the design of this unit, *i.e.*, compressing the two transmission lines into a very small box, and introducing a large amount of high-pass filter action to prevent interference in the i.f. bands from passing through the system. Both problems have been solved at one stroke. The transmission lines are manufactured as bifilar windings around a coil form in the manner shown in Fig. 3. The spacing of the two wires determines the characteristic impedance of the line which is not altered by the fact that the winding appears to be a coil.

The fact remains, however, that it is a coil and as such it has a certain inductance and a certain distributed capacitance. These elements have been calculated so that they form a high-pass filter with a cut-off in the 50 mc. region. The filter action effectively prevents the passage of interfering signals below 50 mc.

The coupler as a whole might be considered as a transformer with a single 300 ohm primary and four 72 secondaries, preceded by an *m*-derived high-pass filter. It is not actually a transformer, however, and it has at least one very important advantage because of its unique method of impedance changing. The antenna looks into an impedance equal to its own (300 ohms) and the output end of each transmission line looks into an impedance equal to its own (150 ohms—two receivers in series). Thus there is a maximum transfer of energy from input to output of the system.

Energy radiated from the oscillator of any receiver and appearing at the antenna terminals does not feed back

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2-WAY FM RADIO-TELEPHONE

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HAND CARRY

HT-21 (25-50 Mc.)
HT-22 (150-174 Mc.)

- FULL TWO-WATT ANTENNA OUTPUT*
- Weighs only 14 pounds!
- Complete, self-contained 2-way radio-telephone station!
- Powered by Dry, or Wet Rechargeable Batteries (can be recharged from car battery or 117 Volts AC)
- Rugged, weatherproof
- 22 sub-miniature tubes!

*On 25-50 Mc. • One-Watt output on 150-174 Mc.

CENTRAL STATION

HT-23 (25-50 Mc.) HT-24 (150-174 Mc.)

Same performance and specifications as the "Littlefone" Hand Carry.

- AC-operated Central Station
- Audio-amplifier, providing one watt of audio for loudspeaker
- Power consumption is 35 watts
- Plugs in any AC outlet (117 Volts)

Where one or more extra stationary receiving stations are desired, Hallicrafters economical S-81 receivers may be added.

A new Hallicrafters product—the "*littlefone*"—is now ready for thousands of important uses in hundreds of industries.

This light, rugged, dependable radio-phone will be offered through Hallicrafters distribution organization—by the men who know communications best.

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AMONG THE MORE IMPORTANT PRESENT USES ARE:

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- MINING (Above & Below Ground)
- PIPE LINE INSPECTION
- ROAD BUILDING
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- CONSTRUCTION
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through the system with anything like the same efficiency. The 75 ohm output of any receiver sees, not its own impedance of 75 ohms, but a high impedance composed of all the other impedances of the system in series, *i.e.*, three 75 ohm receivers and a 300 ohm antenna for a total of 525 or, taking its own internal impedance into account, 600 ohms. The gross mismatch makes for very poor efficiency. As a result, oscillator re-radiation interference between one set and any of the others is greatly attenuated. While it is true that not all the re-radiation goes from the oscillator to the antenna of a receiver through the same path as the input signals and is not subject to quite the same impedance considerations, additional attenuation beyond that directly calculable takes place because the re-radiated oscillator signals do not find impedance matches anywhere and most of the energy is lost through reflection.

Even though most receivers are designed for 300 ohm inputs, the use of 75 ohm cable does not result in an appreciable loss of signal strength, especially if a good antenna has been installed on the roof. One to four receivers can be operated simultaneously, no matter to which channels they are tuned. This is so because, although there is only a 6 db loss of signal in the forward direction, there is a 16 db loss in the reverse direction, which is the isolation between receivers as far as oscillator radiation is concerned. In addition, the four-set coupler acts as a high pass filter to eliminate any interfering signals the antenna may pick up in the i.f. bands.

Working in cooperation with electrical contractors on original installations or independently in existing homes, the TV technician can add to his income by installing such multiple set systems. —30—

TV IN ARGENTINA

ARGENTINA'S first television station, which officially went on the air in Buenos Aires on October 17 of last year, is one of the largest and most modern in the world.

Operating on Channel 7, the new station features a 5 kw. transmitter and a unique 8-bay triangular loop antenna which gives the station an effective radiated power of 45 kw.

The transmitter equipment for this installation was furnished by Federal Telecommunication Laboratories, Inc., of Nutley, N. J. —30—

NEW BRAZILIAN STATIONS

ORDERS for three complete television stations and a microwave link have been placed with General Electric Company by the Brazilian radio chain, Emissoras Unidas.

Two of the television stations will be installed at Sao Paulo and one at Rio de Janeiro. This will make a total of three stations at Sao Paulo and two at Rio.

The microwave link will provide communication between Rio and Sao Paulo, a distance of over 200 miles. —30—

J. E. SMITH, President, National Radio Institute, Wash., D. C.

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by Practicing at Home in Spare Time

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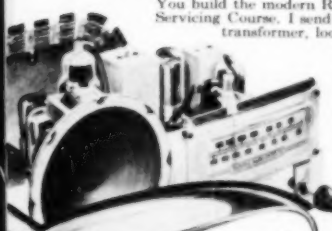
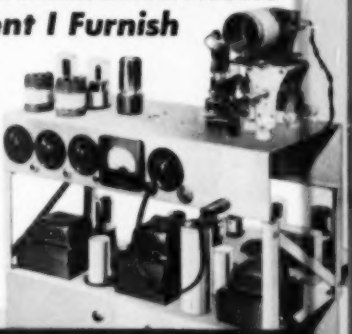
You build the modern Radio (at left) as part of my Servicing Course. I send you speaker, tubes, chassis, transformer, loop antenna, everything you need. You use it to make many tests, get practical experience you need to make EXTRA money fixing Radios. I send you many other kits of parts with which you build other circuits common to Radio and Television, some of which are pictured on the next page. All equipment is yours to keep. See and read about them in my FREE 64-PAGE BOOK. Mail card below.



You Practice COMMUNICATIONS with Equipment I Furnish

As part of my Communications Course I send you kits of parts to build the low power broadcasting transmitter shown at the right and many other circuits common to Radio and Television. You use this equipment to get practical experience putting a station "on the air," performing procedures demanded of Broadcast Station operators. I train you for your FCC Commercial Operator's License that puts you in line for good pay in Radio or Television Broadcasting. Mail card below.



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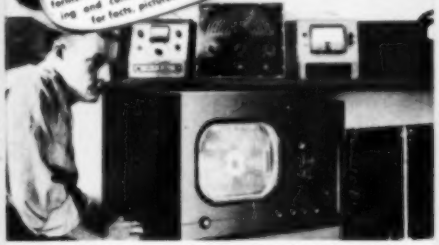

Television Is Today's Good Job Maker

In 1946 only 6,000 TV sets sold. In 1950 over 5,000,000. By 1954, 25,000,000 TV sets estimated. Over 100 TV Stations now operating. Authorities predict 1,000 TV Stations. This means more jobs, good pay for properly trained men. Mail this Postage-Free card NOW for FREE book and sample lesson.

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You Learn by Practicing with Kits I Furnish

With both my Servicing Course and my NEW Communications Course I send you many Valuable Kits of Parts. They "bring to life" theory you learn in my illustrated texts. Some equipment from both courses is shown below and on previous page. All equipment I send is yours to keep. Among equipment you build is a Tester. Use it to make extra money fixing neighbors' sets while training. Special booklets show you how.

Training Features Television

Both my Servicing and Communications training include up-to-date lessons on TV principles. Throughout the country my graduates are filling jobs, making good money in both Radio and Television. Remember the way to a successful career in Television is through experience in Radio.

Send NOW for 2 Books FREE—Mail Card

Send the Postage-Free card now for my FREE DOUBLE OFFER. You get Sample Servicing Lesson to show you how you learn at home. Also my 64-page book, "How to Be a Success in Radio-Television." Read what my graduates are doing, earning; see equipment you practice with at home. Mail card now. We pay postage. J. E. SMITH, President, National Radio Institute, Washington 9, D. C. Our 38th Year.

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"I was a bookkeeper with a hand-to-mouth salary. Now, a Radio Operator."—N. R. Ward, Ridgefield Park, N. J.

Can Step Into FM, Television

"When I enrolled with N.R.I., was a laborer. Now I have a position paying over $10 a day."—R. Ford, Phila., Pa.

Is Broadcasting Operator

"Now employed at station WHAW as operator. I have also opened my own Radio business."—R. J. Bailey, Weston, W. Va.

$10 Week in Spare Time

"Before finishing your course, I earned $10 a week in Radio servicing in my spare time."—S. J. Petruff, Miami, Fla.

$10 to $15 Week Spare Time

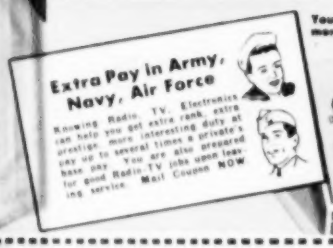
"4 months after enrolling averaged $10-$15 a week spare time servicing Radios. Now have business."—W. B. Weyde, Brooklyn, N. Y.

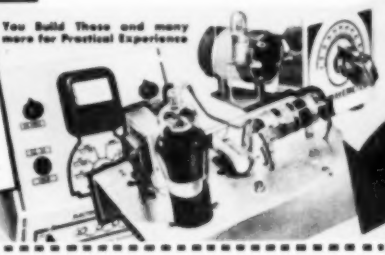
Lost Job, Now Has Own Shop

"Got laid off. Best thing that ever happened as I opened a Radio shop."—E. T. Slate, Corsicana, Texas.

Make Extra Money While Learning

Keep your job while training. Learn Radio-Television principles from illustrated lessons. Get Practical Experience experimenting with circuits common to Radio and Television. Many students make $5, $10 a week extra fixing neighbors' Radios in spare time while learning. I send you special booklets that start teaching you the day you enroll.





Want Your Own Business?

Let me show you how you can be your own boss. Many N.R.I.-trained men start their own business with capital earned in spare time. Robert Dohmen, New Prague, Minn., whose store is shown at right, says, "Am now tied in with two television outfits and do warranty work for dealers. Often fall back to N.R.I. textbooks for information on installing Television sets."

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ponents are subject to vibration and heat at all times, even when the radio is not operating.

The elimination of ignition and motor noise is no longer the tricky problem it was. The new sets have been designed with this in mind. The various car manufacturers have available hints on removing motor noise from their particular models. We use a 250 watt iron and copper braid to ground various parts of the car, when necessary.

Tire static is a problem that can be easily eliminated by injecting special anti-static powder into the inner tube of the tire. A special device to do this, and the powder, can be obtained from *General Cement Company* as well as from the tire manufacturers. A good hint is to also inject it into the spare tire. The reason for this is obvious, sooner or later the customer will have a flat and the spare tire will wind up on one of the wheels.

Fading sets are quite a problem. They can be caused by high generator voltage as well as mechanical distortion of the set. Some service shops recommend putting the set in a large carpenter's vise and subjecting it to different stresses and strains while it is playing. A high generator voltage output will cause output tubes to draw excess grid current and because of this, to distort. A quick check for this is to place the auto radio on 8 volts. Adding an extra cell to a 6 volt battery will accomplish this. Placing the set on 6 volts on a bench from now to doomsday will not show it up.

One of the largest sources of trouble in an auto radio is the vibrator. As you no doubt have noticed, the package in which every new vibrator comes has a warning label which reads something like this "Guarantee void unless buffer condenser is checked." We use an oscilloscope across the primary input to auto radio. Since each vibrator in the auto radio draws a pulsating current, the oscilloscope will read or show this pulsation as a voltage drop or rise. In the preface of the *Radiart* "Vibrator Catalog," there is an excellent description of the functions of the vibrator, condenser, etc. In five seconds, by viewing the oscilloscope, you can tell the condition of the vibrator, the buffer condenser, power transformer, and rectifier tube. It only takes a little practice and you can be an expert in interpreting the pattern on the oscilloscope. Of course, this test can be made without dismantling the set. We make it a practice, whenever we find a shorted buffer condenser in an auto radio, to suggest to the customer that the vibrator be replaced even if it is operating normally at present. If the customer operates his auto radio with a shorted buffer condenser, even for a few minutes, the points of the vibrator are taking such a beating that they are bound to fail in the near future.

We explain to the customer that he will save money in the long run because it will not be necessary to remove the radio from the car or dismantle it. He is free to make his own decision—we do not high-pressure him—but his service card is noted "Customer does not desire vibrator."

If a vibrator has laid on the shelf for a long time, points may become oxidized, or if an auto radio has been in storage for a long time, the points of the vibrator may become oxidized and the vibrator will not start. We use a 100 watt bulb in series with a 110 volt a.c. line to start the vibrator and then let it run for a few seconds. This will burn off the oxide and the vibrator will operate satisfactorily in the future. This same outlet is used to test portables when we suspect the oscillator tube of failing to oscillate at low voltage.

You will notice that the photo of the work bench shows two positions complete with polarized six volt battery outlets and speakers. There are two similar positions in the rear. Most of the test equipment sits on a shelf and can be turned to face either direction. You will also note that each position has a d.c. ammeter, 0-15 amp. scale. If you have seen the same make of auto radio day after day, you know, within ½ an amp. how much it should draw. An excessive reading is, of course, an indication of a shorted buffer condenser or bad vibrator, if the condition persists with the rectifier tube removed. If the current draw is below normal with the rectifier removed, and is excessive when the rectifier is inserted, it means either a shorted condenser in the "B-plus" line or a shorted rectifier tube. This helps speed up the diagnosis.

We have made a small vibrator checker. It only contains two sockets, a standard four prong and an offset four prong. These two sockets will take care of 90% of the vibrators in use today. It consists of an ordinary auto radio transformer, rectifier sockets, buffer condenser, and resistive load. The primary input current is read on the bench ammeter. The output is read on an ordinary d.c. voltmeter and the waveform is analyzed on the oscilloscope. This device requires no additional meters. For convenience, we have a jack and plug to plug in the oscilloscope and meter.

When you do a repair for the radio set manufacturer, he furnishes you with a form on which you list the customer's name and address, delivery date, etc. We use the names on these forms for our mailing list, and we have had special postcards printed telling the customers we are the local authorized factory service station for their particular make of auto radio.

Our Service Department is "open"—no back rooms. We are separated from the customer by a glass panel similar to those used in modern drug store prescription departments. We attempt to show the customer our equipment and manner of working. —30—

ORDER BY MAIL FROM McGEE AND SAVE MONEY!

New Versatile Espey

12-TUBE FM-AM CHASSIS

$64.50

- ★ BUILT IN PRE-AMPLIFIER FOR G.E. VARIABLE RELUCTANCE PICKUP
- ★ WIDE RANGE AUDIO
- ★ MAY BE USED WITH A CRYSTAL MIKE AS A HOME P. A. SYSTEM

McGee's new 1951 model 12 tube FM-AM chassis. Latest design with phono inputs for all types of record players, crystal or G.E. variable reluctance. Inputs for standard broadcast 550 to 1700 kc and FM 88 to 108 Mc. Wide range audio response, push-pull 7C5 and 6n6 beam tube output. Loop for AM. Separate tuning for broadcast and 300 ohm line type antenna may be stapled in cabinet. Attractive lighted slide rule dial. Chassis size 13½x9½ high and 9" deep. Shipping weight 20 lbs. Stock No. 7-CX. Made to sell at a much higher price. McGee's sale price is **$64.50**. Has speaker output matches 8 ohms. **7-CX** chassis with our 12" special FM 12-145 inch **$74.50**. **7-CX** chassis with our 12" special FM 12-145 and latest model 3 speed record changer with crystal cartridge, all for only **$99.45**. Same combination deal as above except changer has the G.E. variable reluctance turnover cartridge. All for only **$106.40**.

SPEAKER AND BAFFLE SALE

8" SPEAKER AND BAFFLE $4.95

Stock No. 818. Tan leatherette covered plywood slant type wall baffle plus an 8" 10-watt, 2.15 oz. Alnico V magnet PM speaker — red hot McGee special for only **$4.95** each, or **$4.70** each in lots of 3 or more, only **$4.95** each, or **$4.70** each in lots of 3 or more.

10" SPEAKER AND BAFFLE $6.95

Stock No. CA-10. Tan leatherette covered plywood slant type wall baffle, plus 10" Permadur, 3.16 oz., Alnico V PM speaker. Only a few hundred to sell at **$6.50** each. **$6.25** each in lots of 3 or more.

12" SPEAKER AND BAFFLE $6.95

Stock No. CA-12. Tan leatherette covered plywood slant type wall baffle plus 12" Quam, 4.04 oz., Alnico V magnet PM speaker. Regular Astatic input model. Terrific McGee value for only **$6.95** each. **$6.60** each in lots of 3 or more.

S-OZ4 TUBE & 5 VIB. DEAL No. RN-V5 ..... $9.50

Here's a red hot deal for you fellows that do a lot of auto radio service. 5 standard brand metal OZ4 tubes and 5 of our famous 4 prong serrated can vibrators. This vibrator is of the latest design, for long life. Standard diameter can, short enough to fit all Chrysler auto sets, also fits Motorola, etc. Our 20th Anniversary, big deal No. RN-V5. You can get 5 OZ4 metal tubes and 5 4-prong vibrators, all for **$9.50**. Shipping weight 2 lbs.

100 Molded Plastic Bypasses $9.95

100 molded plastic tubular bypass condensers. All dirt cheap. And all of the same nationally known mfgr. Regular dealer's net is over ten times the small amount you'll pay at our 20th Anniversary sale price. You'll think when you look these over. Here's what you get: 10—.001, 10—.002, 20—.005, 20—.01, 10—.02, 20—.05 and 10—1. Our big deal No. RN-202. 100 plastic tubulars, shipping weight 2 lbs. Net price, **$9.95**.

150 600 VOLT TUBULARS $6.95

100 top quality 600 volt tubulars at top-past condensers. Made this year by a famous condenser factory. Don't confuse these with ancient, long outdated, McGee's deals are guaranteed to please you. Here's what you get: 10—.001, 10—.002, 20—.005, 20—.01, 10—.02, 20—.05 and 10—.1 600 volt condensers. Our big deal No. RN-203. Shipping weight 2 lbs. Net price, **$6.95**.

20 50 x 30 150 V. ELECTROLYTICS $9.75

Here's a red hot value. 20 of our XX quality electrolytics. The most popular condensers in use today. Takes care of 90% of your AC-DC radio filter needs. Compact construction 1950 production. 1-year guarantee. 50-30-150 volt, housed in a cardboard tube with common negative, has long flexible leads. 20th Anniversary, big deal No. RN-204. Sale price **$9.75**.

SELENIUM RECTIFIERS

65 mil Selenium Rectifier, net ..... **99c** each
100 mil Selenium Rectifier, net ..... **69c** each
130 mil Selenium Rectifier, net ..... **79c** each
250 mil Selenium Rectifier, net ..... **$1.19** each
250 mil Selenium Rectifier, net ..... **1.19** each
350 mil Selenium Rectifier, net. **1.99** each
400 mil Selenium Rectifier, net. **1.79** each

McGee offers you the finest in Selenium rectifiers. All standard 130 volt.

ELECTRONIC RADIO and TV TUBES

- 6 MONTHS' GUARANTEE • INDIVIDUALLY CARTONED
- IN RED AND BLUE DE LUXE VARNISHED CARTONS
- EVERY TUBE SET TESTED FOR YOUR PROTECTION

ORDER 50 ASSORTED—TAKE 10% OFF. Prices as Low as 35c

0Z4	$0.59	6AV6	$0.49	6SA7GT	$0.59	12SR7	$0.59
1A7GT	.59	6AX4	.59	6SC7	.59	12SX4	.59
1L4	.59	6BA7	.59	6SL7GT	.59	12SX6	.59
1R5	.59	6BE6	.59	6SN7GT	.59	12SX7GT	.59
1U4	.59	6BG6G	1.29	6U8	.79	12X4	.59
1U5	.59	6BH6	.59	6V6GT	.59	25A7GT	.59
1U8	.59	6BQ6GT	.99	6X4	.49	25L6GT	.59
3Q5	.59	6BQ7A	.99	6X5GT	.49	25Z5	.59
5T8	.59	6C4	.59	12A7G	.69	35W4	.49
5Y3GT	.39	6C6G	.59	12A7GT	.69	35Z5GT	.59
6AB4	.59	6CB6G	1.29	12AT6	.59	50A5	.89
6AK5	.69	6CG7	.99	12AU7	.69	50B5	.89
6AL5	.49	6CG8G	.99	12AV7	.89	50C5	.89
6AQ5	.59	6CM6	.99	12BA6	.59	50L6GT	.99
6AT6	.59	6E4	.99	12BA6	.59	117Z3	.49
6AU6	.59						

Crosley, G.E., Raytheon, Sylvania, Tung-Sol, etc.

These very low price tubes are made possible by our purchasing from set manufacturers, in bulk quantities and buying tubes in plain white cartons. Each tube has brand and type stamped on carton. Nothing but nationally advertised brands will be shipped to you: Sylvania, National Union, RCA, Tung-Sol, G.E., Raytheon, Jewel, etc. 6 to 6 other good quality, no inferior tubes or seconds. You must be satisfied.

0Z4	$0.39	5U4G	$0.49	6N7G	$0.89	7E5	$0.99
1B3GT	1.10	5Y3GT	.49	6L7G	.89	7F8	.99
1L4	.59	6AB5	.69	6N7GT	.89	7H7	.99
1R5	.89	6AL5	.69	6S7GT	.89	7L7	.99
1S4	.89	6AQ5	.79	6SA7	.99	7N7	.99
1S5	.89	6AU6	.79	6SH7	.89	12A6	.99
1T4	.89	6B8	.99	6SK7	.89	12AB6GT	.99
2A5	.99	6BA6	.89	6SN7GT	.99	12AU7	.99
2A7	.99	6BA6	.89	6U7G	.89	12AV7	1.10
3A4	.89	6BE6	.89	6V6GT	.89	12K8	.99
3A5	.99	6BG6GT	1.25	6W6GT	.79	12Q7GT	.99
3Q4	.89	6C4	.89	6X4	.89	12SA7	.99
5Y4	.89	6J5	1.09	6X5GT	.89	12SK7	.99
5Y4	1.09	6N5GT	.99	7B6	.89	12SR7	.99

1.4 VOLT	AC-DC SERIES	Television Rectifiers	MISC. REC. TYPES
1S5 $0.89	12SA7GT $0.79	LOCTALS	35Z5GT $0.89
1T4 .89	12SK7GT .79	1B3GT $1.10	50A5 .89
1U4 .89	12SQ7GT .79	6AL3 $0.99	50B5 .89
3Q4 .89	35Z5 .89	6BW4 .99	50C5 .89
3S4 .89	50A5 .89	6CA4 .99	50L6GT .89
	50L6GT .79	6CB6 1.09	117Z3 .89

1A4	$0.89	6K7GT	$0.89	7B5	$0.89	12A8GT	$0.89
1A5	.89	6L6	1.49	7B6	.89	12AT7	.89
1A6	.89	6L7	.89	7B7	.89	12AU6	.89
1C5	.89	6L7G	.89	7C5	.89	12AV6	.89
1C6	.89	6N7	.89	7C6	.89	12AX4GT	.89
1D5	.89	6N7G	.89	7C7	.89	12BA6	.89
1D7	.89	6N7GT	.89	7E6	.89	12BE6	.89
1E5	.89	6P7G	.89	7F7	.89	12C8	.89
1F4	.89	6Q7	.89	7F8	.89	12H6	.89
1F5	.89	6Q7G	.89	7H7	.89	12J5GT	.89
1F6	.89	6Q7GT	.89	7J7	.89	12K7GT	.89
1G4GT	.89	6R7G	.89	7K7	.89	12Q7GT	.89
1H4G	.89	6S7G	.89	7L7	.89	12SA7	.89
1H5GT	.89	6SA7	.89	7N7	.89	12SF7	.89
1J6	.89	6SA7GT	.89	7Q7	.89	12SG7	.89
1L4	.89	6SC7	.89	7S7	.89	12SH7	.89
1L5	.89	6SF5	.89	7V7	.89	12SJ7	.89
1N5GT	.89	6SF5GT	.89	7W7	.89	12SK7	.89
1P5GT	.89	6SF7	.89	7Y4	.89	12SL7GT	.89
1Q5GT	.89	6SF7GT	.89	12A6	.89	12SQ7GT	.89
1R5	.89	6SH7	.89	12AD6	.89	12SR7	.89
1S4	.89	6SJ7	.89	12AE6	.89	12SX7	.89
1S5	.89	6SJ7GT	.89	12AF6	.89	12X4	.89
1T4	.89	6SK7	.89	12AH7GT	.89	25A7GT	.89
1U4	.89	6SK7GT	.89	12AL5	.89	25L6GT	.89
1U5	.89	6SL7GT	.89	12AT6	.89	25Z5	.89
2A5	.89	6SN7GT	.89	12AT7	.89	25Z6GT	.89
3A4	.89	6SQ7	.89	12AU6	.89	35W4	.89
3A5	.89	6SQ7GT	.89	12AV6	.89	35Z5GT	.89
3Q4	.89	6SR7	.89	12AV7	.89	50A5	.89
3Q5GT	.89	6T8	.89	12AX4GT	.89	50B5	.89
3S4	.89	6U8	.89	12AX7	.89	50C5	.89
5U4G	.89	6V6GT	.89	12BA6	.89	50L6GT	.89
5V4G	.89	6W6GT	.89	12BE6	.89	117L7	1.49
5Y3GT	.89	6X4	.89	12C8	.89		
5Y4G	.89	6X5GT	.89	12H6	.89		

T.V. BOOSTER REGENCY $19.10

Regency DB-410 television booster. A real engineered unit, small and compact, 9½ tuned, using 2—6J6 tube as neutralized push-pull amplifier. Dollar for dollar, your best booster buy. 5¾x4¾". For 110 volt AC operation. Weight 6 lbs. Net price **$19.10**.

McGee's Super High Fidelity Best Value in U. S. A.

OUTPUT TRANS. 2W-7W-20W 4000 CPS **$7.95**

Model A-403 High fidelity output transformer. Why pay $20 or $30 for an output, when our A-403 is available at $7.95? Impedance, 6600 ohms plate to plate for PP 6L6 or 6V6 tubes. Plate, all windings, 4 to 15-250 and 300 ohm secondary. Housed in a potted case. Net weight 6 lbs. Recommended for all conventional hi-fi systems. Sale price **$7.95**.

GENERAL INSTRUMENT 78 R.P.M. Record Changer SCOOP PRICE $10.95

General Instrument 78 RPM automatic record changer. Plays 10- or 12-inch records automatically. One of the latest models made. Beautiful golden brown hammertone finished base. 12x12⅛". Equipped with an Astatic L-70 crystal cartridge. Heavily flocked turntable and plastic fittings are deep nappon colored. This may be your last chance to offer a 78 RPM changer at this price. Comes packed two to a master carton. Just the thing you'll be looking for in a set manufacturer. Order 2 changers for additional saving. Shipping weight, 2 changers, 20 lbs. Stock No. H-501. Net price, **$10.95**.

10 FP ELECTROLYTICS DEAL RN-10DS $3.49

10 assorted F.P. aluminum can electrolytics. Popular can top tap mounting. Mostly multiple section tanks. 150, 350 and 450 volts. A red hot deal. Shipping weight 2 lbs. Deal 2 RN-10DS. Net **$3.49**.

100 KNOBS Set-Screw Type $1.98

100 bakelite set screw knobs, for radio, set manufacturers, etc. All fit standard ¼" shaft. Assorted walnut, black and ivory. Enough of each style to give you matched sets. This value worth $3.00. Shipping weight 2 lbs. Deal No. RN-10K.

50-WATT BOOSTER AMPLIFIER—$39.95

25-Watt Horn $20.95

50-Watt Booster $39.95

2-Mike Pre-Amp. $10.00 Extra

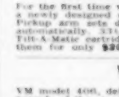
50-WATT BOOSTER A sensational value. 50 watt booster amplifier with push-pull 6L6 output tubes. Connects to your present amplifier as a booster or use with the PA-2X Pre-amp to add the use of 2 mikes and one low level input. The booster amplifier has one input jack and with 1 volt input gives 50 watts of audio. Booster has a 6 db. tilted response high fidelity output transformer, matches speaker with 4-8-16 ohm voice coil, also 66 ohm and 250 ohm line. Booster has a 225 mil power supply with 5U4 rectifier. Size 4 6/8 x 7 3/8 x 6". Shipping weight 14 lbs. Stock No. PA-55X. The two variable controls are for master volume control and bass boost tone control. Size 6 x 6¼ x 14¼. Stock No. PA-55X. Shipping weight 26 lbs. Sale price **$39.95** ea.

2-MIKE PRE-AMP. Pre-amplifier plugs in directly to the PA-55X Booster amplifier. It enables use of 2 Crystal or Dynamic Mikes plus one low level input. Furnished with 4 foot cables and plugs for remote control of the 55 watt Booster Amplifier. Metal chassis size 5 x 3¼ x 4". Stock No. PR-2X, with tubes 7F7 and 7N7. Net price **$10.00** ea.

25-WATT HORN 25-Watt Driver and 3½-foot air column re-entrant Trumpet. The standard bass trumpet and driver you see the most. Drivers are 100% weatherproof, horn is made aluminum, offered by us at a considerable savings. Stock No. MA-53. Shipping weight 20 lbs. Net price **$26.95**.

3-SPEED CHANGERS ON SALE AT McGEE

WEBSTER CHICAGO 3-SPEED Regular $47.50 List Only $24.95



Webster Chicago Model 100-16 3 speed automatic record changer with crystal cartridge and all speed Sapphire needle. 1 needle plays all records. Base size 12x12¾". Shipping weight 14 lbs. This offer good only as long as our stock lasts. A special purchase makes this offer possible. Webster Chicago 3 speed changer, Model 100-16. Sale price **$24.95**.

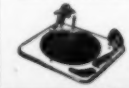
WEBSTER CHICAGO MODEL 100-2 ONLY $26.95

For the first time we offer the world famous Webster-Chicago, model 100-2. Features a newly designed spindle, that drops the records flat, air-cushioned to the turntable. Plays any combination of records automatically after the last record plays. Plays all records automatically, 33⅓, 78 and 45 rpm. New balanced tone arm with Electro-Voice T-16 A Matic cartridge with dual needles. Ordinarily cost over $47.00. McGee offers them for only **$26.95** each. Base size 12"x12¾". Shipping weight 14 lbs.

V.M. 3-SPEED MODEL 406 $22.95

VM model 406, deluxe 3 speed automatic record changer. Plays them all, intermixes records of the same speed. Equipped with a flip over crystal pickup with twin needles. Base size, 12¼x13". Shipping weight 12 lbs. VM-406. Net price **$22.99**.

GENERAL INSTRUMENT 3-SPEED $19.95



Another tremendous McGee record changer scoop. Only 500 to sell. General Instrument 3 speed automatic record changer with standard crystal cartridge and all purpose permanent needle. Brand spanking new. Our first offering of a 3 speed changer at less than $20.00. We purchased a large quantity and pass our saving on to you. Stock No. GI-3384. Sale price **$19.95** each. Price to the small manufacturer in lots of 48 or more, **$19.50** each.

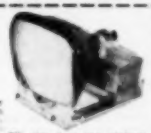
McGEE RADIO COMPANY Prices F.O.B. K.C. Send 25% Deposit with Order Balance Sent C.O.D. With Parcel Post Orders, Include Postage

TELEPHONE VICTOR 9045. WRITE FOR FLYER. 1422 GRAND AVE., KANSAS CITY, MISSOURI

NEW TELEVISION "SLAVE" KIT FOR 16 TO 20 INCH TUBE $39.95

COMPLETE 16 TO 20 INCH TELEVISION "SLAVE" KIT

$39.95 LESS TUBES



Television Slave Kit, Model No. SK-21: for use with 16, 17 or 20 inch rectangular picture tubes, as well as on 10 or 12 inch round tubes. It may be connected to your present TV receiver, regardless of screen size, to give a second TV slave unit sometimes referred to as a TV duplicator. You pick up the TV signal at the picture tube grid. The audio is picked up at the high side of the audio gain control. These two connections are all that is necessary on your present set. A two tube cathode follower kit is supplied with the slave kit so that there will be no loading of your present set. The duplicator kit itself is 14¾" wide and 21" long. A ready punched chassis and complete hardware kit is furnished. The circuit is a straight forward AC transformer type. The circuit employs the following tubes: (2) 6SN7, horizontal and vertical amplifiers, (2) 6AL5 phase detector and DC restorer, 6K6 vertical output, 5Y4 rectifier, 6K6 audio, 6BQ7 horizontal output, 6W4 damper, 1X2 high voltage rectifier, 12AL7 2nd video separator, (2) 6AL5 are used in the cathode follower. No speaker is furnished. This kit is the same essentially as a full TV kit, except that it has no tuner or video. All resistors, tube sockets, a power transformer, etc., are furnished along with a screwdriver and instructions. WARNING: Only those who understand TV, should buy this kit, as television is very complicated and should not be attempted unless you know what you are doing. TV Duplicator Kit, Model SK-21 less all tubes. Net price **$39.95**. Shipping weight 38 lbs. 8" PM speaker, **$2.95** extra. Kit of 12 receiving tubes for SK-21, **$10.00** extra. 17BP4A, 17" blackface picture tube, **$21.95** extra. 20CP4A, 20" blackface picture tube, **$39.95** extra. (Specify when ordering, which picture tube that you intend using.)

CONVERT TO A RECTANGULAR PICTURE

With each conversion kit you get a plastic mask, 70 degree deflection yoke, 90 day guaranteed black face picture tube, plus your own TT21-X 14,000 Volt Universal flyback and transformer output transformer that works on any output tube and any single rectifier 1B3 or 1X2. A suggested diagram is furnished for use of the transformer with several different output tubes and rectifiers. We think this is the finest and best priced conversion kit in the country. Shipped Truck or Express, only

Kit No. TCK-14, with 14BP4A 14" rectangular tube.	Net price	$27.95
Kit No. TCK-16, with 16BP4A 16" rectangular tube.	Net price	29.95
Kit No. TCK-17, with 17BP4A 17" rectangular tube.	Net price	34.95
Kit No. TCK-20, with 20CP4A 20" rectangular tube.	Net price	49.95

BUY YOUR WIDE RANGE COAXIAL SPEAKER AT McGEE

12" COAXIAL PM $12.95

A $32.50 retail value. 20 watt 12" coaxial PM speaker of quality used on radios of the $300 to $500 bracket. Hook up like any PM speaker. High pass filter is built on speaker. Matches 8 ohm output of radio amplifier. Wide range response, 20 to 17,500 CPS. Model No. CU-15. Ship. wt. 9 lbs. Special sale price, **$12.95**.

15" COAXIAL PM $19.95

Only $19.95 buys a full 15" 20 watt coaxial PM speaker with built-in high pass filter. Hook to any 8 ohm output on radio or amplifier. Response better 20 to above 17,500 CPS. Good 4 to 1 frequency. A lucky purchase makes this price possible. Full 32 oz. magnet in the woofer. 5" tweeter. Model P15-9. Ship. wt. 11 lbs. Sale price, **$19.95**.

100 ASST. RESISTOR KIT

100 for $2.49

Ohio Carbon, 100 resistor assortment. You get 50, 1 watt and 50, ½ watt sizes, from 100 ohms to 10 meg. ohms. A good assortment to have around. Made and packaged by Ohio Carbon. Kit contains 100 pcs. of 10 megohm resistors. This is used only to indicate ohmages covered. Stock No. OH-100, 100 assorted resistors, **$2.49**.

50 1 WATT
50 ½ WATT

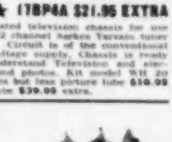
COMPLETE 17" TO 20" T.V. KIT

★ AC-TRANS-TYPE
★ CONVENTIONAL CIRCUIT
★ READY WIRED 12 CHANNEL T.V. FRONT END
★ 70° DEFLECTION ★ CERAMIC FLYBACK
★ KIT OF TUBES EXCEPT KINE $16.95 ★ 17BP4A $21.95 EXTRA

$59.95 LESS TUBES

A complete kit of parts to build an AC transformer operated television chassis for use with a 16, 17 or 20 inch rectangular picture tube. The 12 channel Sarkes Tarzain tuner is ready wired. The 4 tube video IF strip is also wired. Circuit is of the conventional sweep design with latest ceramic type flyback high voltage supply. Chassis is ready punched. Warning: Do not buy this kit unless you understand Television and electronics. It is difficult to wire. We furnish schematic and photos. Kit model WK 20 strip weight 40 lbs. less all tubes **$89.95**. Kit of 19 tubes but less picture tube **$50.95** extra. 17 inch 17BP4A **$21.95** extra. 20CP4 inch rect. tube **$39.95** extra.

SARKES TARZIAN 3-TUBE T.V. TUNER $7.95



This popular Sarkes-Tarzian television front end is widely used today. The 12 channel rotary switch type with individually tuned coils. Price includes a schematic diagram and 3 tubes, 6C4 osc. 6BH6 RF and 6AU5 mixer. Regular factory cost is twice our price. Each tuner and its own tube socket are wired, ready to hook up to a video and sound IF strip. May be used with either intercarrier or separate sound IF circuits.

Built-in fine frequency control. Shipping weight 3 lbs. Sarkes-Tarzian Type 3 Tuner with tubes. Net **$7.95**

Combination deal: Sarkes-Tarzian TV tuner and 2d5-AX video coil kit, both for **$14.95**

Sarkes-Tarzian Type 3—Same as Type 2 only has input IF coil built-on. Tapped for sound IF channel. Net **$9.95**

Above tuners offered with either 2½ inch or 4¾ inch shaft length. 3-tube Sarkes-Tarzian tuner with 2¾ shaft but no fine tuning. With tubes 12AT7 and 2GA5. Stock No. TX-3T **$7.95** with tubes.

RCA T.V. FRONT END $9.95

Terrific buy on this RCA TV tuner. We have a limited quantity of the famous original 201E1, 12 channel completely wired and tested TV front end tuning. Ready to connect to any TV video IF strip. Offered at a sacrifice. Price was originally **$44.00**, now only **$9.95** each, less tubes. You'll save plenty on this item. 6J6 tubes are required. Stock No. RCA-12F TV front end tuner, **$9.95** each, two for **$19.00**. 6J6 tubes **75c** each, extra.

New RCA Printed Circuit Tuner complete with 6BC5 and 6J6 Tubes **$19.95**.

GENERAL INST. T.V. FRONT END Sale Price $7.95

All completely wired, brand new and pre-aligned. 13 channel selector incorporating fixed inductance and variable capacitance. Converter output transformer is attached to be coupled direct to separate sound and video I.F.'s. 20.65 tubes are required. Built in fine frequency control. Original factory cost over **$30.00**. Weight 4 lbs. Stock No. GI-13P less tubes. Net price **$7.95**.

Stock No. GI-13PX Same as above only not in new condition. Have been in sets, but guaranteed a good value—less tubes. G. Inst. Tuner GI-13PX, net **$2.95**.

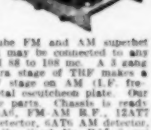
Either of the above G.I. tuners are available with either 6¼" or 1¼" shafts. Specify which shaft you desire, when ordering. 6J6 tubes **99c** each, extra.

SENSATIONAL NEW 2-BAND RADIO KIT ONLY $14.95

7-TUBE FM-AM TUNER

MODEL RAL-8

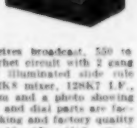
★ AC SELF POWERED **$29.95**
★ 3 GANG TUNING ★ A COMPLETE KIT



McGee has ready for delivery, this self powered AC, 7 tube FM and AM superhet tuner kit. Build yourself a professional looking tuner that may be connected to any audio amplifier. Receives broadcast 550 to 1650 kc and FM 88 to 108 mc. A 3 gang tuning condenser is used on both FM and AM. This extra stage of THF makes a smoother working tuner. 1 IF stage on AM (1 IF transformer, frequency 456 and 10.7 mc). Lighted slide rule dial with metal escutcheon plate. Our own lab designed and wired an original tuner using these parts. Chassis is ready punched and painted. Everything furnished including 6BA6, FM-AM R.F., 12AT7 mixer, osc., 6BA6 I.F., 6BA6 FM limiter, 6AL5 FM ratio detector, 6J7G AM detector, 1st audio, plus rectifier and diagrams. Shipping weight 12 lbs. Stock No. RAL-8, net price **$29.95**.

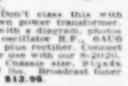
MODEL ME6-2 $14.95

NEW MODEL 6-TUBE, 2-BAND RADIO KIT
A FULL 2-GANG SUPERHET KIT
RECEIVES 550-1600 KC PLUS 6-18 M.C.



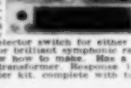
McGee's new 1951, 6 tube, AC-DC 2 band radio kit. Receives broadcast, 550 to 1600 kc and short wave, 6 to 18 mc. A straight forward superhet circuit with 2 gang tuning condenser, 456 kc I.F. transformers, etc. 5" speaker illuminated slide rule dial. Everything furnished, including tubes, 12BK7, R.F., 12K8 mixer, 12BK7 I.F., 12SQ7 detector, 1st audio, 35L6 output, 35Z5 rectifier, diagram and a photo showing view of underside of chassis. The chassis pan and dial parts are factory production. With this kit, you can build a commercial looking and factory quality 2 band radio, housed in a streamlined plastic cabinet. Size: 13 x 6¾ x 6¼". Stock No. ME6-2, shipping weight 10 lbs. Net **$14.95**.

SELF POWERED AC Broadcast Tuner Kit, 3-Gang Tuning, Complete Kit, $12.95



A self-powered, 3-gang superhet tuner kit with R.F. stage. When wired according to our diagram, will make a top quality broadcast tuner (550 to 1650 kc) for use with any amplifier. Don't class this with ordinary tuners; this has its own power transformer. This complete kit is furnished with a chassis, tubes and all parts. 6AU6 R.F., 6BE6 oscillator R.F., 6AU6 I.F. detector, 6AL5 double duty, 6V6 output tube to any audio amplifier. Ideal for use with our S-20/20, TM-16 or TX5 amplifier kits. Chassis size, 9½x6x4½ inch high. Shipping weight, 7 lbs. Broadcast tuner kit Model BT-38X. Net price, **$12.95**.

8-TUBE 22 WATT Wide Range Amp. Model Tx5 Kit Only $37.95



A complete kit, including tubes (3-7S7, 2-7F7, 2-6A3, plus rectifier, diagram and photos. All triode circuit makes for minimum harmonic distortion. Inputs for radio tuner any kind of phono pickup (crystal or G.E. variable reluctance) and either crystal or dynamic mike. Output transformer matches 8 ohm voice coil. Twin electronic tone controls, bass and treble with range selector switch for either juke box quality or high fidelity. Response 18 to 20,000 CPS, 6 db. Ultra linear output. Weight 25 lbs. Net **$37.95**.

10-TUBE RADIO KIT $29.95

3-GANG TUNING
MIKE INPUT
12 WATT
HI-FI AUDIO
BASS-TREBLE BOOST

A NEW 1951 ALL-PURPOSE RADIO KIT

10-Tube Broadcast (550 to 1700 kc) Radio Kit for custom builders. Features 3-gang superhet circuit with A.V.C., high gain IF circuit, 6" slide rule dial, chassis is size 12½" long, 10" front to back, 6½" high. Audio inputs for a crystal or dynamic mike, and record changer or player. Tone compensation for standard crystal pick-up or General Electric variable reluctance. Push-pull 6V6 output tubes, shielded high fidelity output transformer matches 8 ohm PM speaker, husky power transformer, 2 tone controls for separate bass and treble boost. A complete kit, including tubes 6SK7 R.F., 6SA7 mixer, 6SK7 I.F., 6H6 detector, AVC, 6SQ7 1st audio, 12AX7 variable reluctance and mike amplifier, 12AX7 phase inverter, 2-6V6 outputs, plus rectifier, diagram and instructions. Shipping weight 18 lbs. Stock No. HR-R10. Net price **$29.95**. 10" PM speaker, **$6.00** extra. Crystal tube and desk stand, **$4.95** extra. 12" coaxial speaker **$12.95** extra.

5-Tube Broadcast SUPERHET RADIO KIT $12.95

Model RS-5 tube AC-DC superheterodyne radio kit. Has loop antenna and 2 gang condenser, with lighted slide rule dial and attractive plastic cabinet. Receives broadcast, 550 to 1650 kc. Full size dynamic speaker, matched 456 I.F.'s, automatic volume control. This is a complete radio kit. Everything furnished, including diagram, cabinet and tubes: 12BE6 mixer, 12BK7 I.F., 12SQ7 detector, 1st audio, 50L6 output, 35Z5 rectifier. Shipping weight 12 lbs. Stock No. RS-5. Net price **$12.95**.

Build Your Own Phono-Mike Broadcaster $7.95

Kit Model DE-6R. With this simple kit, you can build a 3-tube phono oscillator that also has a mike input. Will broadcast over any radio, within your home, about 75 feet from 1000 to 1500 kc. Inputs for crystal mike or crystal phono pickup. Fader control fades from mike to record. Ideal for a home P.A. system, baby listener and home entertainment. A complete kit of parts including tubes. Kit Model DE-6R. Net price, **$7.95**. DE-6RWT, wired and tested. Net price, **$9.95**. Crystal mike and desk stand, **$4.95** extra. Concealed microphone unit, only 1" in diameter and ½" thick. Specify hidden mike when ordering. Stock No. T-001. Net, **$3.95** extra.

6-TUBE AC-2-BAND KIT $16.95

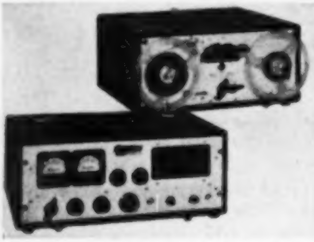
A New 2-band radio chassis kit, features 3-gang tuning, full AC circuit with power transformer, complete with diagram, all parts and tubes. 6SK7 R.F., 6SA7 mixer, 6SK7 AVC, 1st audio, 6V6 output, plus rectifier. Chassis size, 7" deep, 6" high, 12½ long, 7½" slide rule dial. Ideally suited for schools, etc. A straight forward superhet circuit complete except for speaker and cabinet. Output transformer is part of radio kit. Stock No. RA-61. Shipping weight 8½ lbs. Net price **$16.95**. 6" PM speaker **$2.79** extra. 8" PM **$3.49** extra.

WHAT'S New in Radio

For additional information on any of the items described herein, readers are asked to write direct to the manufacturer. By mentioning RADIO & TELEVISION NEWS, the page, and the issue number, delay will be avoided.

BINAURAL RECORDING

Magnecord, Inc., 360 N. Michigan Avenue, Chicago 1, Illinois, has developed a new binaural tape recorder



which records the sound through two separate microphones.

In the new system each of the microphones records on a separate side or channel on standard ¼ inch sound recording tape. Since the two channels are recorded at the same time and reproduced simultaneously through two separate speakers and/or two separate headphones, the effect is that of the listener's ears actually being present at the time the recording was made.

The new amplifier has been designated the Type PT6-BN. When used with the PT63-A binaural mechanical unit, it provides two complete recording and playback channels.

Complete details on this new system are now available from the company.

DELUXE RECORD PLAYER

A lightweight portable record player has been added to the line of audio equipment being produced by *Newcomb Audio Products Company*, 6824

Lexington Ave., Hollywood 38, California.

Known as the Model RC-12, the new player features a powerful 5 watt, a.c. amplifier, a *Webster* changer, and a 6" x 9" Alnico V PM dynamic speaker. The unit plays 33⅓, 45, or 78 rpm recordings.

The operating panel includes a tone control, volume control, and pilot light. A kickproof metal grille protects the speaker. The unit is housed in a sturdy carrying case of solid plywood construction, covered with durable, washable fabricoid material. Total weight is 31½ pounds and the unit is *UL* approved.

NYLON RETAINING RING

Cambridge Thermionic Corporation, 463 Concord Avenue, Cambridge 38, Massachusetts, has developed a new nylon-phenolic terminal retaining ring which is said to greatly extend the scope of its ceramic coil forms.

The new rings in no way impair the moisture and fungus resistant qualities of the coil form assemblies but provide new benefits not available heretofore. They are excellent for bifilar windings. The four separate terminals, two on each nylon-phenolic ring, mean secure individual connections for each coil lead.

In applications using single pi wind-

ings, terminals can be located above or below the winding to shorten wiring to circuit elements. In addition, soldering spaces are doubled, as the shape of the terminals affords two soldering spaces on each to segregate coil terminations from circuit wiring.

All materials and finishes meet government specifications. The new rings are available with the company's LST, LS5, and LS6 coil forms.

MATCHING TRANSFORMERS

Atlas Sound Corp., 1449 39th Street, Brooklyn 18, New York, has developed a new line of weatherproof matching transformers which is specifically designed to permit the sound technician to match all of the company's "Dual Projector" and "Paging and Talk-Back" speakers to either constant voltage (70 volt line) or constant impedance systems. Transformer taps eliminate the need for complex computations.

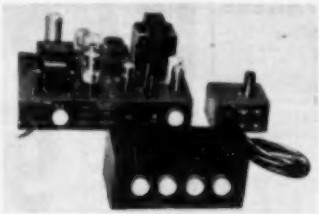
These new transformers are mounted in a heavy steel protective housing that prevents mechanical or atmospheric damage. Double rubber grommets and gaskets protect the cable connections entering the transformer housing. The convenient transformer bracket is

easily integrated with the speaker mounting bracket and no extra fastenings are needed.

Two models are currently available —the Model T-11 with primary taps for 500, 1000, 1500, and 2000 ohms, and secondary windings of 4 and 8 ohms. The Model T-12 has a primary of 45 ohms and a secondary of 4 and 8 ohms. Both models will handle 12 watts.

BOGEN AMPLIFIER

A new high fidelity amplifier and remote control unit have been announced by *David Bogen Company, Inc.*, 663 Broadway, New York 12, New York.



The Model H010 power amplifier and the Model RXPX remote controller and preamplifier provide quality music reproduction for the serious listener. The H010 is an all-triode amplifier rated at 10 watts output. It delivers its full rated output with less than 1.3% distortion over the entire frequency range from 20 to 20,000 cps.

The remote controller and preamplifier provides full control of function selection, volume, tone, and record equalization at distances up to 25 feet from the amplifier.

Detailed specifications on either or both of these units will be furnished by the company on request.

PICKUP CARTRIDGE

The Astatic Corporation, Conneaut, Ohio, has developed a new phonograph pickup cartridge employing a condenser harness which slips on or off the terminals to change the output from a high of 4 volts to a low of 1.2 volts at 1000 cps.

The L-12-U may be used as a replacement for more than 125 different standard 78 rpm cartridges now in use. Another feature of this dual-output

cartridge is a needle chuck limiting principle which restricts motion of the chuck both radially and lengthwise. This feature helps to prevent dislocation of the chuck and to protect against

(*Continued on page* 112)

MADE IN FRANCE
5" HI-FI HIGH POWERED PM SPEAKER

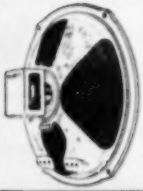
$1.98 EA. 2 for $3.75 While they last

Stock No. S-106

3½ lb. Magnet
Fully adjustable voice coil
Here is the best PM speaker at the best price you ever saw. Made in France by French craftsmen. A truly custom built speaker you'll be proud to demonstrate. Painstakingly made down to the final finishing touch which are outstanding blue and grey.

Features include a 1½ lb. magnet, felt compression gasket, voice coil leads are sewn onto cone, fully adjustable voice coil, wide range frequency response, power output 6 watts.
Easily rate at $10.00 but the manufacturer forgot to perform one little operation, drill mounting holes in the rim. But this should make little or no difference to you if you want to get the finest imported precision speaker for a fraction of its cost. Shipping wt. 4 lbs.

MAGNAVOX & RCA SPEAKERS
12" and 8" Sizes



Think of it! Genuine Magnavox and RCA Speakers at a fraction of their real value. Yes—Olson really made a deal—a good deal—and you can cash in. These speakers are brand new, equipped with Alnico 5 magnets and dust-proofed 3.2 ohm voice coils.

STOCK UP NOW—THIS IS REAL VALUE

12" PM Speaker—Individually boxed. Single, ea. $5.99
Stock No. S-140—Lots of 5, ea. **$4.95**

8" PM Speaker
Individually boxed
Stock No. S-123 ..... EA. **$2.99**

Stock No. AS-50 **$5.00**

100 Popular Knobs
★ Olson's Best Buy
You get 100 knobs—with a guarantee that they are worth at least the what you pay. Included are set-screw and push-on type in Black, Mahogany, Ivory White, as well as fancy colors.

VOLUME CONTROL KIT
10 ASSORTED SINGLE AND DUAL CONTROLS
$2.99
AS-44
List value $18.50. Contains 10 popular single and dual controls, with and without switch. All 10 cost you less than the normal price of just two if bought regularly.

10 WATT RESISTOR KIT
AS 46
We mean to move 50,000 fine 10 watt wire wound resistors during this sale, hence this low price. PRICE OF THIS KIT IS $15.00. Each kit contains 20 popular insulated resistors, with tinned copper leads. Shpg. wt. 2 lbs.
KIT OF 20 **$2.49**

GENUINE UNIVERSITY REFLEX SPEAKERS

20 WATT DRIVER UNIT No. S-165
$14.70 each

Unit is breakdown proof, will handle 25 watts continuously and is guaranteed for 1 year. Hermetically sealed, complete protection from outdoor exposure. Has dural 16 ohm voice coil and genuine bakelite diaphragm. Fits trumpet shown below or any other standard trumpet. Brand new factory sealed cartons. Shpg. wt. 6 lbs.

REFLEX TRUMPET No. S-164
$14.41 each

Trumpet is heavy gauge metal finished with corrosion resistant paint. Equipped with famous adjustable UNIVERSITY BRACKET. Mounts in any position, 16½" diameter. Has heavy rubber rim for improved tone. Brand new factory sealed cartons. Shpg. wt. 18 lbs.

Get both Driver Unit and Reflex Trumpet (genuine University matched set **$29.11**

TL-3 FAIRCHILD GRINDER
$9.98

Every service shop needs one of these handy tools made by Fairchild, famous manufacturer of precision electric grinders. Regular nationally advertised price is $19.75. The set consists of 1—115 volt high speed, air cooled grinder, 6 assorted grinding wheels, 1 circular saw blade, 1 hard steel reamer, 1 buffing brush, 1 abrasion stone, and 1 6 piece set. Brand new case size 10"x8"x7" to house the grinder. Shipped in original factory sealed cartons.

RECORDING TAPE—Famous Mfr's Close-Out!

Get the buy of your life. Save up to 66⅔% on high quality RECORDING TAPE. A large manufacturer had to sell his inventory and he unloaded the whole deal. Olson now offers you this high grade recording tape at prices which defy competition. Standard 1/4" wide, 1200 ft. long. Frequency response 50 to 8,000 cy. Plastic Reel included with each.

PAPER BASE— 1200 ft.
Stock No. R-249
Single, each $1.60
Lots of 10, each **$1.49**

PLASTIC BASE 1200 ft.
Stock No. R-349
Single, each $2.10
Lots of 10, each **$1.99**

PRICES SLASHED ON EMPTY PLASTIC REELS
Finest Clear Plastic—Will Not Warp

5" Diameter—400' Size No. R-280
Single, ea. 30¢
LOTS OF TEN, EA. **29¢**

7" Diameter—1200' Size No. R-295
Single, ea. 45¢
LOTS OF TEN, EA. **39¢**

TUBES UP TO 73% DISCOUNT

Order your tubes from Olson and make more on every sale. Discounts range up to 73% off list on the tubes shown. Every tube is INDIVIDUALLY BOXED and GUARANTEED. Every tube is made by Ken-Rad, Sylvania, Tung-Sol or Raytheon and will be so branded or carry the Olson or Jarrad Brand or the brand names of set manufacturers like Crosley, Motorola, Zenith, Philco, etc. Here's a deal you need. Almost every set that comes into your service shop needs tubes. Be ready—get your stock from Olson.

6Y3GT, 6J5, 6N4, 6X5GT, 12AT6, 12AV6, 35W4, 35Z5, 80 — **59¢ Ea.**

OZ4, 1H5GT, 5U4, 1S5, 6AR5, 6AV6, 6BE6, 6H6GT, 6SQ7, 6X6GT, 12BA6, 25L6GT, 12BE6 — **69¢ Ea.**

1R5, 1T4, 1U5, 3V4, 6AL5, 6AQ5, 6AU6, 6BA6, 6SA7, 6S4, 6W4GT, 7B4, 12SA7, 12SK7, 12SQ7, 35C5, 50B5, 50C5, 50L6 — **79¢ Ea.**

1LE3, 6CB6, 6V6GT, 6W6GT, 12J7GT, 12SN7GT, 25W4GT, 35Y4 — **89¢ Ea.**

6SN7, 1X2, 6AG5, 1B3GT, 6K7GT, 6L6G, 6J6, 7N7, 12AT7, 12AU7 — **99¢ Ea.**

6AG7	$1.19 Ea.
6BG6G	1.89
6BQ6GT	1.29
6CD6	1.99
12AV7	1.19

TUBE KITS

Buy in kits and save money. Brand new fresh stock. Made by Nationally Famous manufacturers and packed in handsome shelf cartons. Order some of each.

ALL AMERICAN TUBE KIT
Kit contains one each of the following: 12SA7, 12SN7, 12SQ7, 35Z5, 50L6. Reg. list price $8.80
Kit No. AS-11—Per Kit **$3.75**

2 KITS	4 KITS	6 KITS
$7.50	$15.00	$22.25

MINIATURE TUBE KIT
Kit contains one each of the following: 12AT6, 12BA6, 12BE6, 35W4, 50B5.
Kit No. AS-47—Per Kit **$3.39**

2 KITS	4 KITS	6 KITS
$6.75	$13.25	$19.50

REMEMBER! Every Tube is guaranteed. Make more money on your service work. ORDER TUBES FROM OLSON'S GIANT WAREHOUSE.

AMAZING RECORD PLAYER DEAL
$10 Worth of RCA Discs Included

$19.97 Stock No. RA-60

RCA VICTOR YOUTH SERIES NON-BREAKABLE RECORDS

This is not a kit. The phonograph comes to you completely assembled and factory tested. No troublesome wiring. Just plug in—put on the RCA non-breakable records you get with the outfit and you have dependable entertainment. The amplifier employs 2 tubes, a 50L6 and a 35Z5. Motor is Alliance, the finest. The crystal tone arm is made by Astatic. Sure and Electro-Voice. In addition you get a complete set of RCA Victor non-breakable Children's Records which include such favorites as "Happy the Monkey," The 500 Hats of Bartholomew Cubbins," "Rapunzel," "Aladdin and His Lamp," etc. Discs are enclosed in beautifully colored albums giving each story so that the child can follow the recording. Cabinet is decorated with gay circus figures and the volume can be regulated by the full range control. Operates on 115 volts AC. Shpg. wt. 15 lbs. Don't delay, order now. The price is low enough so it pays to order even for the parts contained.
Here is a special. You get a Nationally famous 78 RPM Record Player and $10.00 worth of genuine RCA Victor non-breakable children's records.
LIMITED QUANTITY. ORDER NOW WHILE THEY LAST.

*Look what the parts would cost if bought separately even at our SPECIAL SALE PRICE.

78 RPM Motor	$ 3.79
Phono arm and cartridge	2.99
Amplifier	3.98
Set of tubes for amplifier	1.80
PM Speaker	1.69
Output Transformer	.59
AC Cord	.29
Decorated Case	4.99
Set of RCA Victor Non-Breakable Records	10.00
	$30.11

FAMOUS BRAND 3-SPEED AUTOMATIC RECORD CHANGER
$19.99 RA-40

- Sorry, we promised not to mention the manufacturer's name.
- Automatically Plays 7", 10" and 12" Records.
- Plays All Type Discs—All Speeds 33⅓, 45 and 78 RPM.

Completely automatic and what's more it's one of the most famous brands in changers. Precision built by experienced craftsmen. Every changer brand new in original factory packing, 100% guaranteed to please or your money back. Here is one of Olson's most sensational bargains. Believe us—you can't go wrong. Order one or more but we can't promise to repeat this offer. We have a limited quantity and when they are gone—no more.

The changer has a reject lever and a control for selecting 33⅓, 45 or 78 RPM speeds. Plays all 7", 10" and 12" records. Equipped with an Astatic Ceramic cartridge and a sapphire long life needle. Records drop gently and smoothly—just like velvet. Operates on 115 volts, 60 cycles AC. Base 12x12½". Zinc plate and 3½g" below. Shpg. wt. 15 lbs.

OLSON RADIO WAREHOUSE • 275 E. Market St., Akron 8, Ohio

JIFFY STEEL PARTS CABINETS

The first time Olson offered these handy cabinets they were a sell-out! Just what you need for all your small parts. Engineered for strength. Cabinets are durable steel finished with baked enamel. Drawers are sturdy plastic in a convenient size of 3¾" Deep, 2¾" Wide, 1¼" High, and each is equipped with two removable sliding separators. Drawers have safety catches, will not spill contents if pulled out too far.

AVAILABLE IN 6 SIZES.

No.	Description	PRICE
X-231	8 Drawers, 24 compartments, 6" deep, 8¾" wide, 8" high	$3.59
X-232	12 Drawers, 36 compartments, 6" deep, 8¾" wide, 8" high	4.95
X-233	16 Drawers, 48 compartments, 6" deep, 12⅛" wide, 8" high	6.59
X-252	24 Drawers, 72 compartments, 6" deep, 8¾" wide, 15⅝" high	8.99
X-234	32 Drawers, 96 compartments, 6" deep, 12⅛" wide, 15⅝" high	10.95
X-235	64 Drawers, 192 compartments, 6" deep, 23" wide, 15⅝" high	20.95

STACKED CONICALS

FULL 20 ELEMENT

In lots of 3, each $8.66

AU-96

With matching Q bars and High Frequency Mast. Genuine Aircraft Aluminum elements. High gain stacked conical. Will pull in those stations in "Fringe Areas." Works on all channels. Easily assembled.

THIS IS A TERRIFIC VALUE!

Each Antenna consists of 2 conical bays plus a pair of matching Q bars. Less mast. Packed—3 Antennas to a carton. This gives you six bays and 3 pairs of Q bars.

Sold Only in Boxes of 3 Antennas

AU-96
Carton of 3
Weight 25 lbs.

$25.98

COMPLETE TV CONICAL ANTENNA KIT

Nothing More to Buy

$17.99 Stock No. AU-67

Latest model, Genuine Aircraft Aluminum Tubing. Everything you need to erect a high gain 20 ele test (including 75" type antenna. HERE'S WHAT YOU GET: 1 stacked deluxe 20 element conical antenna with high frequency stubs; 2 5-ft. steel mast sections; 1 U.L. approved 6 foot lightning arrester; 1 steel chimney mounting assembly with necessary strapping; 75-ft. 300 ohm twinline; 6 insulated screw-eye standoffs; and 2 insulated mast standoff insulators.

The antenna has a conical pattern providing high gain on ALL channels. All the necessary installation parts are packed with the antenna. Here's the economical way to buy. Have everything at hand for that installation. Order those kits NOW. This is real Olson Value. Shpg. wt. 25 lbs.

TWIN LINE

300 Ohm Poly Twinline

High quality, low loss. For all TV and FM installations. Shpg. wt. 2 lbs.

Stock No. W-73.
100 ft. coil $2.99

OPEN WIRE TV LINE

★ Use in Place of 300 Ohm Line

Ideal for fringe area installations. Not affected by moisture or sun. Made of #18 copperweld wire with genuine polystyrene insulators spaced 6" apart. Tensile strength 400 lbs.

$ Stock No.	$ Stock No.
W-72. 100 ft. coil. Shpg. wt. 4 lbs.	W-73. 300 ft. coil. Shpg. wt. 9 lbs.
$2.95	$14.90

BIGGEST BARGAIN

Special while they last for the combination

$3.99 RA-91

COMBINATION OFFER—You get an Allinone Rim Drive 78 RPM Phono Motor with turntable PLUS a Pickup Arm with high Output Cartridge.

PHONO AMPLIFIER

RA-19.

$3.98 LESS TUBES

A real high efficiency 3-tube amplifier of modern design. Connect to any crystal phono pick up and speaker. Has volume and tone controls. 7"w 3¼"d 2¾" h. Shpg. wt. 3 lbs.

SET OF TUBES FOR AMPLIFIER 12SQ7 50L6 35Z5 No. AA-32 $2.64

RIM DRIVE PHONO MOTORS

Stock No. M-79

TOP QUALITY

Single, each $2.19
In lots of 3, ea. $1.99

Plays all 10" and 12" 78 RPM records. Quiet, rutted smooth friction drive motor with turntable. For 115 volts 60 cy AC.

3 SPEED M-83

Self starting, complete with turntable. Operates on 115 volt AC 60 cy. Shpg. wt. 5 lbs.

$5.99

3-SPEED PHONOGRAPH Special

$19.97 RA-56

Plays 78-45-33⅓ RPM Discs

Finest components in the manufacture of these gorgeously designed phonographs. Features include: 3 speed Allinone motor, heavy flocked turntable, 3-volt output tone arm with precision-tip needle, volume control, 2 tube built-in amplifier, Alnico 5 PM speaker, leatherette covered case with rounded corners, convenient carrying handle. Order early and order enough. Every phonograph 100% guaranteed. Original factory-sealed cartons. Operates 115 volts AC. Shpg. wt. 15 lbs.

PICTURE TUBES RCA 16GP4 $24.95

OLSON'S SPECIAL

Dark Face

Brand new genuine RCA 16GP4 with the new DARK FACE. Fully guaranteed. Ship your tubes from Olson at less than Jobber Cost. 70° deflection. 17-11/16" long, neck 6⅛" long, metal envelope.

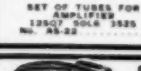
12" CO-AXIAL SPEAKER

$13.95 S-160

Woofer-Tweeter Design. Response 40 to 12,000 CPS

12" woofer section is driven by a heavy 2-pound magnet and this part delivers the bass notes. 3" tweeter which is built into the center of the speaker is driven by a 2¼ oz. Alnico 5 magnet and delivers the treble notes. High pass filter is built into the speaker and the entire combination gives you tone you never dreamed possible. Only two wires to connect to any radio or amplifier and the speaker is ready to play.

Voice coil impedance is 8 ohms. Shpg. wt. 8 lbs.



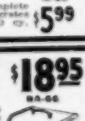
$4.95 M-64

3 SPEED PICK-UP ARM

Cartridge tips by means of a lever. Dual cartridge, one side plays 33⅓ and 45 and other 78 RPM. Double needle.

TINY MOUTH AMPLIFIER $18.95

★ Small in Size ★ Giant in Action



BA-66

While they last Olson offers these amplifiers which are ideal for window demonstrations, record playing announcing, etc. Here's what you get. A three-tube amplifier with tube, 6" PM speaker, and a two-tone leatherette covered case 5½"x8"x10". Has input for either phonograph or crystal mike. Operates on 115 V. AC. 60 cy. Can be used with microphone shown below.

LOUD MOUTH AMPLIFIER

★ Limited Quantity ★ 8 Watts

Stock No. RA-67 ... $24.95

Made by craftsmen and now offered by Olson at a real knockdown price. CHECK THIS OUTFIT TODAY! Here's what you get. A full 8 watt Amplifier with tubes, 6SC7, 6V6 and 5Y3. 8" PM Speaker with heavy duty cone and a two-tone leatherette case—size 6" x 10½" x 12". Has volume and tone control. You can connect 2 mikes or a mike and a phonograph simultaneously. Operates on 115 V AC 60 cy. Can be used with microphone shown below.

FP CONDENSER KIT

Assortment of 15 regular FP condensers, double and triple sections. Capacities from 10 mfd to 50 mfd, from 25 to 450 volts. Shpg. wt. 2 lbs. One of Olson's giant values.

$3.98 AB-94 each

3 Speed AUTOMATIC CHANGER

Stock No. RA-76.

$42.95 WHILE THEY LAST

COMPLETE with VM Model 950 Changer, Amplifier, Speaker and Case. A real Olson value if we ever saw one! Here is the latest VM Model 950 Automatic Changer built into a beautiful carrying case with speaker and fine Amplifier. Plays twelve 7" records (33⅓ or 45 RPM), twelve 10" or ten 12" (33⅓ or 78 RPM). 100% automatic in operation. Nothing more to buy when you order this fine player from OLSON. The amplifier is equipped with a long life needle. Motor shuts off after last record. Equipped with volume control and tone control. Speaker is Alnico V PM. Carrying case is beautifully covered. Size 15" x 17" x 8". For 115 volts 60 cy. AC. Regular list price $77.95.

MICROPHONE

High output crystal mike for PA systems and recorders. Equipped with handle base and 7' shielded cable. Shpg. wt. 2 lbs.

M-67. each $5.95

M-66. same but with on-off switch built into handle $6.95

THIS COSTS YOU NOTHING—NOT A RED CENT

Just to get the ball rolling and to get your order to come our way—Olson is going to send you one of his famous TERMINAL STRIP KITS. Contains a total of 56 terminal boards, tag strips, screw terminals, tie points and panel lamp sockets. You get the entire package of 98 popular parts which should be in every service shop. All you need do is to make up an order for $10.00 or more from this ad . . . using this order blank. We will ship your order at once and include the 56 piece kit at no extra charge.

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MONEY BACK GUARANTEE: *Everything you order from Olson is guaranteed as advertised. If you are not more than satisfied, you may return merchandise for cash refund.*

Please Minimum Order $3.00

QUANTITY	STOCK NUMBER	DESCRIPTION	PRICE EACH	TOTAL

NAME _____ TOTAL

ADDRESS _____ ADD POSTAGE

CITY _____ ZONE ____ STATE ____ TOTAL AMOUNT

RN152

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If you live in or near Chicago visit our store, get these and many more bargains.

MAIL ORDERS SHOULD BE SENT TO AKRON, OHIO

OLSON RADIO WAREHOUSE • 275 E. Market St., Akron 8, Ohio

Shirt Pocket Radio

(Continued from page 44)

is required. If the regeneration control is advanced to maximum, this station may be heard clearly all over the room if the headphone is held in the cupped hand. For weak signals and also those at the extreme low frequency end of the broadcast band more care is required in tuning. For best results, first tune the station for best reception without adjusting the regeneration. Next, advance the regeneration control until the detector just oscillates, as will be evidenced by a slight rushing sound. Then back off the regeneration control until the rushing stops. Now retune the station, which will now be at its maximum volume. Using this method, the author has received (in the daytime) station WTMJ in Milwaukee, a distance of 85 miles. Its signal could be called "barely understandable," but nevertheless audible. Station WIND whose transmitter is in Gary, Indiana, a distance of 40 miles, can be heard easily. At night, reception is not limited to locals. The original set has "pulled in" large, clear channel stations from as far as 400 miles away!

It will be noted that the antenna is bi-directional. If the set is rotated until the signal fades completely, then the knobs point either towards or directly away from the station being received. This could conceivably serve as a kind of radio direction finder for a person lost in the woods, provided he were able to tell general directions. For purposes of general reception, the directivity of the antenna bothers us little, as the nulls are very sharp, whereas the peaks are very broad. This means that a given station can be received over about 340 degrees rotation of the set. There will be two ten degree nulls where the station fades out. This is not objectionable, as one may turn a corner while listening, and very seldom hit the ten degree null!!

Litz Wire Loops

The performance of the receiver, as outlined in this article, is good. However, there is one way that it may be improved, *i.e.*, introduce a larger signal at the input grid! The signal pickup of a loop antenna is proportional to the area thereof. However the *voltage* across any tuned circuit, loop antennas included, is also proportional to the "*Q*" of the circuit. "*Q*" is the ratio of the reactance to the resistance of a coil. To raise the "*Q*" of the antenna loop, it is only necessary to use a heavy litz wire. By using 35-44 litz wire, the "*Q*" of the antenna is raised from 75 to 220. The signal delivered by such an antenna will be almost three times that delivered by one wound with #30 solid wire. The author has not specified litz wire for the loop in this article, due to the general unavailability of litz, however, he recommends it highly to those who may be able to get some. Use 20-44 to 55-44 single silk enameled for best results. If the highest possible performance is desired, the set may be redesigned mechanically so that the "A" cell, switch, and tuning condensers are outside the loop. The "shorted turn" effect of these components will materially affect the "*Q*" of a loop wound of litz reducing its efficiency as much as 40%. Do not use small litz wires, such as 5-44 or 10-44. They are virtually no better than solid wire and the additional difficulty in handling these sizes is not justified by any notable increase in performance.

–30–

Service Aids

(Continued from page 51)

shown in Figs. 3 and 6. Basically this is a two-section balanced attenuator giving a total attenuation of approximately 35 db, unshielded, up to about 220 mc. For convenience we have mounted the resistors on an insulating board and added a set of alligator clips in such a manner that they fit all standard TV antenna terminals. *Scotch* tape helps keep the clips in place and prevents them from shorting to the chassis. The input and output impedance of the attenuator is normally about 300 ohms, but by shorting out the two series resistors in each lead, a 50 ohm input or output can be achieved.

The application of this attenuator lies mostly in checking TV receiver sensitivity and fringe area operation. In many instances a technician may get strong signals at his shop, but service receivers in a weak signal area. By connecting this attenuator between the antenna lead-in and the receiver under test, weak signals will be obtained. Occasionally a set will tend to be regenerative under weak signals and bench testing is difficult because strong signals are found at the shop. Using only one side of the antenna is not always permissible because unbalance occurs and in many receivers unbalanced input will greatly alter the response of the r.f. tuner. Using this attenuator reduces the signal to any desired level while maintaining proper balance and impedance match. If the circuit shown in Fig. 3, gives too much attenuation, remove one set of resistors and use only one I-section. On the other hand, if more attenuation is desired, another section can be added.

Other applications of this balanced attenuator network include signal reduction to avoid overloading on one particularly strong station, demonstrating sensitivity characteristics of different receivers, and checking booster operation. When a booster is connected to a receiver having an efficient automatic gain control circuit, little difference will be observed as long as strong signals are received. Often a booster is tagged as weak for that reason. To check its performance under weak signal conditions, connect the attenuator pad between the antenna and

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6Z4G		6AC5GT	1.04	6J6	1.04	7A7		12BF6	.59	35C5	
1A5GT	.65	6AC7		6J7G	.79	7A8		12BH7	.87	35L6GT	.59
1A7	.79	6AG5	.95	6J8G	1.15	7B4		12C8	1.15	35W4	.45
1B3GT	.95	6AG7	1.15	6K5GT	.87	7B5		12F5GT	65c	35Y4	59c
1B5	29c	6AH6	1.40	6K6GT	.59	7B6	.65	12H6		35Z3	
1C7G		6AK5		6K7GT	.79	7B7	.65	12J5GT	.54	35Z4GT	54c
1E7		6AK6	.87	6K8GT	.87	7B8	.65	12K7GT	.79	35Z5GT	
1H6		6AL5	72c	6L5G	.95	7C4	1.15	12Q7GT	.65	35Z6G	.95
1N5GT	.65	6AQ5		6L7	.87	7C5		12S87GT	.95	35 51	.79
1N6G	$1.15	6AQ6	.65	6N6G	1.40	7C6	65c	12SA7GT	.72	41	
1J5GT	.95	6AR5	.59	6N7GT	87c	7C7		12SC7	.79	42	72c
1L4	.29	6AT6	.54	6P5GT		7E6	.79	12SF5GT		43	
1LA4		6AS5	.72	6Q7GT	.65	7E7	.95	12SF7	72c	45	
1LA6	95c	6AU5GT	.95	6R7GT	.95	7F7	.79	12SH7GT	.79	45Z5GT	.59
1LC5		6AU6	59c	6S4	.65	7F8	1.15	12SJ7GT	.65	46	1.04
1LC6		6AV6		6S7GT	1.15	7G7	.95	12SK7GT	.72	47	
1LD5	.95	6B4G	1.15	6S8GT	.95	7H7	.72	12SL7GT	.87	50A5	.79
1LE3	.95	6B5		6SA7GT	72c	7J7		12SN7GT	.79	50B5	72c
1LH4	.95	6B6G	.79	6SC7		7K7	95c	12SQ7	.54	50C5	
1LN5	.95	6B8GT	1.15	6SD7GT	1.04	7L7		12SQ7GT	.59	50C6G	1.04
1N5GT	.72	6BA6	.65	6SF5	.59	7N7	.79	12SR7GT	.79	50L6GT	.59
1P5GT	95c	6BA7	.87	6SF5GT	.65	7Q7	.72	12Z3	.95	70L7GT	1.40
1Q5GT		6BC5	.72	6SF7	.72	7R7	.79	14A7	.79	80X6	.79
1R5	72c	6BC7	.79	6SH7GT	.79	7S7		14AF7	.87	80Y6GT	.59
1S5		6BD5GT	1.15	6SJ7	65c	7V7	95c	14B6		80Y7GT	.72
1T4		6BE6	.65	6SJ7GT		7W7		14B8	79c	71A	.87
1U4		6BF5	.79	6SK7GT	.72	7X6	.79	14C5	.95	75	72c
1U5	.65	6BF6	.59	6SL7GT	.87	7X7	.95	14C7	.87	77	
1X2A	.95	6BG6G	1.29	6SN7GT	.79	7Y4	65c	14F7	.79	78	
2A3	1.15	6BH6	72c	6SQ7	.54	7Z4		14F8	1.15	80	.45
2A5	.79	6BJ6		6SQ7GT	.59	12A7	1.15	19BG6G	2.35	85	.79
3LF4	.95	6BN6		6SR7GT	.65	12A8GT	.79	19T8	1.04	117L7	
3Q4	.79	6BQ6	1.15	6S57	.72	12AH7GT	.95	20	1.40	117N7GT	1.40
3Q5GT	.87	6BQ7	1.58	6T7G	1.15	12AT6	.54	24A	.79	117P7GT	
3S4	72c	6C4	59c	6T8		12AT7	1.04	25AC5GT	1.04	117Z3	.54
3V4		6C5GT		6U5	.72	12AU6	.72	25BQ6GT	1.15	117Z6GT	.87
5T4	$1.40	6C6	.79	6U6GT	79c	12AU7	.65	25L6GT	.59	807	1.95
5U4G	.59	6C8G	1.15	6U7G		12AV6	.54	25W4GT	.72	813	9.95
5V4G	.87	6CB6	.72	6V6GT	.72	12AV7	1.15	25X5	1.04	1294	29c
5W4	59c	6CD6G	1.69	6W4GT	.65	12AW6	.95	25Z6GT	.79	1299	
5W4GT		6D6	.79	6X4	54c	12AX7	.87	32L7GT	1.15	1619	.45
5X4G	.65	6D8G	1.15	6X5GT		12BA6	.65	35A5	.59	1629	.29
5Y3GT	.45	6E5	.79	6Y6G	.87	12BA7	.87			2050	2.00
5Y4G	.54	6F5GT	59c	7A4	.72					2051	1.15
5X4G		6F6GT		7A5	.79					7193	.87
5Z3	65c	6F8G	1.15							VT51	29c
6A3	$1.15	6G6G	.95							VT52	
6A8GT	.79	6H6	.59								
6AB5 6N5	.95	6H6GT	.65								

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6AU6	ea. 59c	6BG6G	ea. $1.29
12AU7	ea. 65c	6CD6G	ea. $1.69

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1Q4, 1T4, 1R5, 1S5. List Value $8.90. Tube Kit only — $2.39

1S4, 1T4, 1S5, 1R5. List Value $7.80. 4 Tube Kit — $2.39

1U4, 1S4, 1S5, 1R5. List Value $7.80. All Four Tubes for — $2.39

3V4, 1R5, 1S5, 1T4. List Value $7.90. All for — $2.39

117Z3, 1U5, 3V4, 1R5, 1T4, AC-DC Portable Kit. All for — $2.89

12AT6, 12BA6, 12BE6, 35W4, 50B5. 5 Tubes for — $2.95

50L6GT, 35Z5GT, 12SQ7GT, 12SK7GT, 12SA7GT. 5 Tubes for — $3.22

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12LP4	$16.95	16RP4	$29.95
12LP4A	$19.95	16TP4	$29.95
14PB4	$22.95	17BP4A	$31.95
7JP4	$17.95	19AP4A	$39.95

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Insulated ½, 1 and 2 watt assortment of most used values, best brands. 100 for 50 asst.—$2.25 — $3.95

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½ watt	20%	3½c ea.	1 watt	20%	4½c ea.
	10%	5c ea.		10%	7½c ea.
	5%	9½c ea.		5%	15c ea.
2 watt — 20%			10 for 60c		
2 watt — 10%			10 for 95c		
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the booster input and then compare pictures with and without the booster. When you wish to show a fringe area customer the difference in fringe performance of various receivers, you can simulate fringe conditions right in the shop by using the attenuator pad shown in Figs. 3 and 6. Or if the fringe receiver requires peaking the video i.f. section you can do that in the shop, check the response curve on the oscilloscope and sweep generator and also check the picture with the attenuator inserted in the antenna leadin. If excessively strong signals are received in a particular location it may be impractical to operate without an antenna because of strong ghosts. Connect the attenuator permanently to the antenna terminal of the set to avoid overloading, or, if other stations come in weaker, use a double-pole, double-throw switch to connect the attenuator into the circuit only when required.

As we stated in the beginning, the items described in this article are but a few of many which can be made by the technician at very little expense and which help to speed up and simplify TV repairs. Of those mentioned here, all can probably find more applications than we can think of and once they are available it is up to the technician to make the fullest use of them. A few minutes invested occasionally in working out a handy gadget or simple service tool will always be repaid by faster and more efficient television servicing. —30—

TV LINK TO CANADA

AUTHORITY to build the U.S. end of the first international television link, between Buffalo, N.Y. and Toronto, Canada, has been granted to the Long Lines Department of the American Telephone and Telegraph Company by the FCC.

Antennas will be added to the Bell System microwave station at Buffalo to beam U.S. network programs across the border to a Toronto-Montreal radio-relay system now under construction by Bell Telephone Company of Canada.

Bell of Canada has a 5 year contract with CBS to provide this service.

—30—

"Junior!"

Manufacturers' Literature

Readers are asked to write directly to the manufacturer for the literature. By mentioning RADIO & TELEVISION NEWS, the issue and page, and enclosing the proper amount, when indicated, delay will be prevented.

MANUAL SUPPLEMENT

A new TV control replacement manual supplement is now being offered to TV technicians by *Clarostat Mfg. Co., Inc.* of Dover, New Hampshire, through its regular jobbers.

The company issued a manual last spring listing standard and exact-duplicate controls available in its line. This new supplement provides a continuation of this listing.

The new supplement has been compiled to aid technicians in stocking and ordering controls. It lists by receiver manufacturer the frequency of use of the various controls. In this way the technician can carry the stock he needs to service the prevailing makes of receivers in his specific area.

SERVICE NOTES BINDER

RCA tube distributors are now offering dealers and service technicians a three-ring leatherette binder designed for the filing of individual *RCA Victor* service data booklets.

A "bonus" plan has been devised whereby these binders may be obtained without charge. Details on how these binders may be secured are available from the company's tube distributors.

SOUND CHART

Newcomb Audio Products Co., 6824 Lexington Avenue, Hollywood 38, California, is currently offering copies of a new wall chart of impedance mismatch and line loss vs. line impedance and line length.

This handy chart will be sent to sound specialists and audio installation engineers without charge. In making requests for this publication please ask for Chart 103.

MIDGET RELAYS

Signal Engineering & Mfg. Co., 154 W. 14th St., New York, New York, has issued a new four-page bulletin which describes and illustrates its Series 80 line of midget telephone type relays.

The booklet contains information and drawings giving types of covers, characteristics, general specifications, and other pertinent data.

When requesting copies of this booklet, ask for Bulletin MTR-151.

OXFORD CATALOGUE

Oxford Electric Corporation, 3911 South Michigan Avenue, Chicago 15, Illinois, has just published a new cata-

logue covering its complete line of PM speakers, electrodynamic speakers, units for TV replacement, auto radio replacement, p.a. applications, intercoms, and outdoor weatherproof speakers.

Complete data is given on the company's full line ranging from 2" to 15" units. Copies of the catalogue are available from the company without obligation.

GC CATALOGUE

Of interest to radio and television technicians is the new 64-page 1952 catalogue just released by *General Cement Manufacturing Company* of 919 Taylor Avenue, Rockford, Illinois.

Designated catalogue No. 155, this handy new publication lists hundreds of radio and electronic products ranging from adhesives, tools, hardware, cabinets, accessories, etc., to wrenches and wrinkle varnish.

Copies of this new publication will be supplied free on request.

SERVICING BOOKLET

The *Bendix Radio Division* of *Bendix Aviation Corporation*, Baltimore 4, Maryland, has begun the distribution of a cartoon booklet for television technicians entitled "Blue Book of TV Servicing."

The booklet contains 40 pages of "do's and don't's" and tips for TV technicians on how to get along with the customers he visits. Each point of servicing conduct has been illustrated by cartoonist Yardley of the "*Baltimore Sunpapers*" and "*Pathfinder*" newsmagazine. Printed in two colors, the booklet is of convenient size for easy reading.

MILO CATALOGUE

Milo Radio & Electronics Corp., 200 Greenwich Street, New York 7, N. Y., has just published a comprehensive 1100 page catalogue listing over 75,000 items in the industrial electronic, radio, television, sound, and broadcast fields.

This hard-cover catalogue deals specifically with items for the industrial field and includes listings of tubes, panel meters, laboratory test instruments, relays, switches, condensers, resistors, transformers, plugs, jacks, connectors, wire, metal chassis and cabinets, dials, knobs, voltage regulators, pilot light indicators, etc.

Distribution of this 1952 catalogue is confined to purchasing agents, chief engineers, and other company officials who make their requests direct to Dept. HK on company letterhead.

SELENIUM RECTIFIERS

The Rectifier Division of *Sarkes Tarzian, Inc.*, 415 North College Avenue, Bloomington, Indiana, has just issued a comprehensive catalogue covering its line of power selenium rectifiers.

Designated PR1, the publication shows isothermal, frequency, and reverse current vs temperature curves in addition to data which heretofore has not been available in printed form.

Information on conventional circuits, selenium cell ratings, typical selenium rectifier stacks, and data on stack connections is also included.

Engineers desiring copies of this catalogue should make their requests direct to the company.

SIGNALING DEVICES

Lee Electric Co., 132 Beckwith Avenue, Paterson, New Jersey, has recently released a new 8-page catalogue covering its line of signaling devices.

Included in the booklet is information on bells and buzzers, transformers, lamp ballasts, push-buttons and accessories, and other electrical specialties. The company will supply a copy of this catalogue to anyone making a request direct to the firm.

SOUND SYSTEMS

Bell Sound Systems, Inc., Columbus 7, Ohio, is currently offering copies of its new catalogue No. 5152.

This 20-page booklet carries data on the company's line of amplifiers, recorders, record players, portable p.a. systems, industrial equipment, intercommunication systems, accessories, speakers, and line matching transformers.

B-A CATALOGUE

A new catalogue for dealers, technicians, hams, engineers, and experimenters has just been released by *Burstein-Applebee Co.*, 1012-14 McGee Street, Kansas City, Mo.

This 1952 catalogue contains 136 pages and lists thousands of items used in the radio and electronic fields. The listing includes amateur equipment, amplifiers, antennas and accessories, auto receivers, speaker baffles, batteries and plugs, cabinets of all types, TV boosters, chassis, audio components, communications receivers, radio parts, servicing tools, tubes, hardware, kits, TV accessories, recorders, etc.

Copies of this handy catalogue are available from the company on request. Please ask for Catalogue No. 521.

PARTS CATALOGUE

Radiolab, 1608-14 Grand, Kansas City 8, Missouri has just issued a comprehensive new catalogue for dealers, technicians, and manufacturers covering radio, television, and electronic parts.

Known as Catalogue 86, the new publication is a veritable handbook of components and equipment. The index is a particularly complete one and in addition to listing equipment by type, products are listed by manufacturers' names.

A copy of this 1952 catalogue will be forwarded upon written request to the company.

INDUCTION HEATING BOOKLET

Westinghouse Electric Corporation has announced a new 12 page booklet on the subject of induction heating.

The booklet presents case histories of how induction heating has increased production from 50 to 2000 percent, reduced space requirements up to 90 percent, and cut production costs. It also tells how batch handling can be changed to in-line production methods and how in one case an induction heating machine handles 432 different parts.

A copy of this booklet, B-4782, may be had by addressing a request to *Westinghouse Electric Corporation*, Box 2099, Pittsburgh 30, Pa. —30—

The official opening of the 3d Armored Cavalry Regiment's MARS station recently gave Fort Meade its second MARS station. Dedicated by Col. James O. Curtiss, Jr., commanding officer of the 3d Cavalry Regiment, who sent a message to a detached element of his unit, the new station has been assigned MARS call letters AA3WAX and a regular ham call of K3WAX. Sgt. Stuart Robinson, regimental signal supply sergeant, is in charge of the new station and is seen at Col. Curtiss' left.

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Letter from Chief Engineer, Broadcast Station, Tennessee: "Have opening for operators. If you have men please have them contact us."

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Howard J. Kirchassey, Rt. 2, Box 736, El Cajon, Calif.	2nd class telephone	49
Ralph I. Nichols, 510 Elm St., Kerrville, Texas	2nd class telephone	36
Elbert L. Risinger, P.O. Box 122, Bedias, Texas	1st class telephone, 2nd class telegraph	36
Harry R. Rogers, R.R. 6, Lafayette, Indiana	2nd class telephone	50

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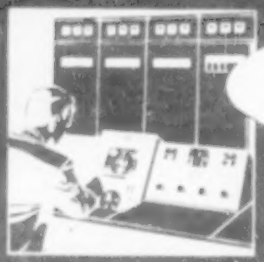

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W. M. Chambess, Radio Station WLOS, Asheville, N. C.

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Frank Schooles, Asst. Eng., CHEX, Ontario, Canada.

After working at WHIZ for two years doing control room engineering, my 1st class ticket has already netted one raise in pay, with more to follow. Thanks for a well planned course and for the School's cooperation."
John P. Armstrong, 1349 Newman Drive, Zanesville, Ohio.

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Robert J. Schilling, Chief Engineer, Radio Station WIMS, Michigan City, Ind.

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Artificial Hangover

(*Continued from page 61*)

able, the a.c. reactance of all of the power supply elements should be calculated for the lowest frequency that the amplifier will handle. For example, a ten microfarad condenser, a fairly common value in filter circuits, will have an a.c. reactance of approximately 800 ohms at 20 cycles and in the case of output tubes having relatively low impedance plate loads a relatively large voltage may be developed across the condenser at this frequency.

Aside from the advantages of improving the apparent acoustics of the reproducing environment, artificial hangover has a number of other very important applications. One of these is the fact that it can give the effect of very greatly improved "transient" response from conventional loudspeakers. The reason for this is the fact that the conventional loudspeakers may require a definite period of time to build up to maximum peak acoustic output. As a result, transients of very short duration may not be reproduced at all, even though an acoustic environment were present which would allow the listener to hear them if reproduction had been perfect. By introducing additional hangover in the signal *before* it reaches the loudspeaker, transients with very brief initial duration may last long enough to bring the acoustic output from the speaker to the proper level. By making the amount of hangover introduced of the same order as that produced by the worst ringing resonance in the speaker very smooth transient response which should be superior to virtually any mechanical arrangement of loudspeakers may be obtained. However, in the writer's experience, it appears desirable to use this technique on speakers which do not evidence any serious ringing resonances as the improved response tends to make cross modulation due to the resonance more noticeable due to the greater *average* power contained therein. In the case of speakers in which the original transient response falls off gradually at a rate of approximately 6 db per octave in relation to the steady state response, the hangover technique appears to work very well in that a hangover of 100 cycles at ten thousand cps, ten cycles at one thousand cps and one cycle at one hundred cps all represent the same time duration of one one-hundredth second, an interval not too easily recognizable by the ear. Thus the apparent transient response of the speaker can be made to closely simulate the steady state characteristics. Similarly, if hangover is properly introduced, it can considerably reduce the audible effects of serious resonances in the reproducing system by making the audible output more uniform over an appreciable band of frequencies, thereby tending to eliminate "one note thump"

such as is found in the bass regions of some systems. However, as previously noted, care should be taken that serious cross modulation does not take place.

Another factor of definite importance is the fact that hangover can actually multiply the over-all efficiency of amplifiers, speakers, and similar devices by greatly reducing the ratio between the peak and average powers which must be transmitted for a given amount of audibility. In speech or music this ratio is claimed to be as high as four hundred to one on a power basis. This ratio is occasionally used as a justification of very high power audio equipment for home use and would be a correct assumption if no acoustic hangover were introduced either in the original pickup or in the acoustics of the reproducing environment. However, if hangover is present, and as noted earlier it is a very important element in tonal quality, then the ratio of peak-to-average power content will be much lower, with the result that much less peak audio power is required and the attendant problems are diminished. On the basis of limited observation it seems likely that from ten to twenty cycles of linearly decaying hangover will be quite acceptable, with the result that the actual efficiency of an amplifier or loudspeaker may be increased from five to ten times in the case of transients with very short duration. This factor should readily lend itself to applications in which it is desired to obtain the maximum possible signal-to-noise ratio, *e.g.*, the highest average level practical. One possible application of this is the music distribution system, such as the juke box, in which it is desired to have good tonal rendition under conditions of appreciable background noise. An experimental installation by the author resulted in a system with good clean bass response at a level which did not seriously interfere with conversation in the vicinity. Similarly, the previous high intensity peaks which had tended to deafen listeners and produce ear fatigue were eliminated. Of particular interest to some users should be the fact that artificial hangover tends to greatly improve the character and audibility of outdoor reproduction.

For the high quality enthusiast, a number of other benefits may be achieved through use of controlled hangover, principal of which is correcting for some of the distortions that may arise in the elements of the reproducing chain. One of these is in reducing the effects of intermodulation distortion that may be present in a signal by means of demodulation or smoothing out due to the hangover. Likewise, a much greater apparent dynamic range may be produced from a signal which previously contained relatively little hangover, and in a similar manner an apparent increase in signal-to-noise ratio can be obtained when the noise is of sufficiently continuous nature, such as hum, that hangover does

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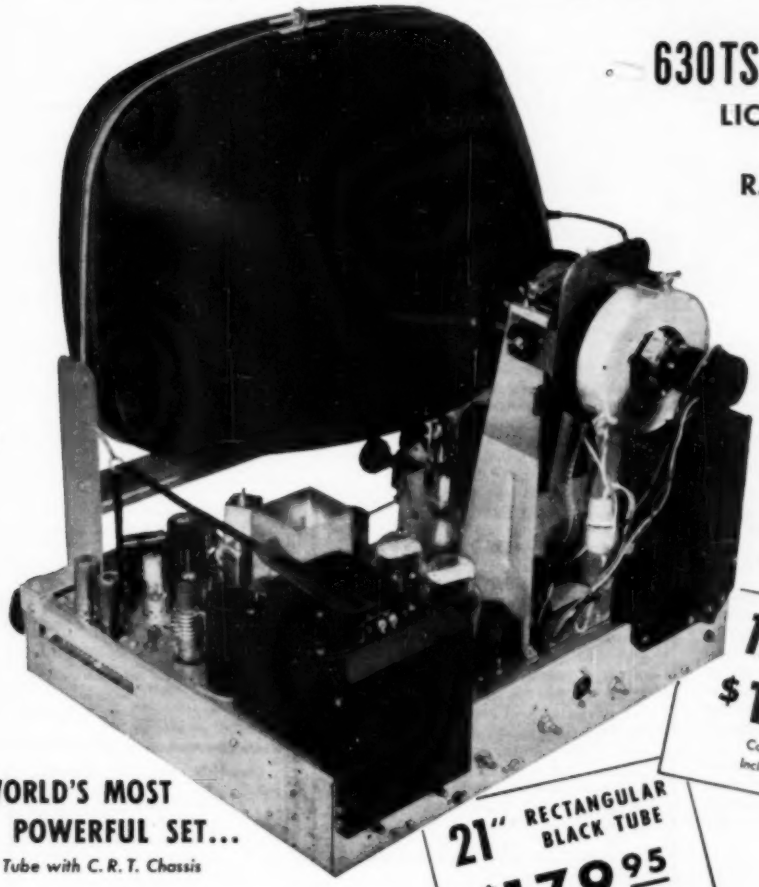

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not increase its audibility. The same may apply to noise such as needle scratch if it is of a fairly constant nature and the system does not tend to "ring" at any one frequency.

Another interesting advantage of controlled hangover is in correcting for nonlinearity in the reproducing chain. As nonlinearity usually causes weak signals to be suppressed in the presence of strong ones, a low amplitude transient wave train may be damped too rapidly when passing through a nonlinear element. This is very apparent in some cases in which a particular instrument will sound as if it were almost stripped of harmonic content in the reproduction. If the initial portions of the low amplitude wave trains still exist, partial compensation may be achieved by introducing hangover. Another form of nonlinearity may exist in which some portion of the system refuses to pass signals below a certain amplitude. This may be noted in electromechanical devices, such as speakers, pickups, and microphones, as well as in some amplifier circuits. A similar effect is produced by the human ear in the presence of an appreciable noise level. Again the result is that damped wave trains are not produced for their full duration and require the application of additional hangover for naturalness.

In conclusion it should be noted that the artificial hangover system proposed in this article is not the same thing as the conventional "echo" chamber which, though useful in specific applications, is not applicable in the sense in which the phase delay hangover system is used, inasmuch as the phase delay system permits exact relationships to be maintained between the initial transient and the hangover at any frequency, while the echo chamber, or even the best of present day concert halls, may present problems due to phase interference. The advantages of controlled hangover should be appreciated by anyone who likes music whether he be a musician or high fidelity enthusiast with a critical ear, or someone who is simply searching for a pleasing combination of sounds. —30—

Low-Pass Filter

(Continued from page 38)

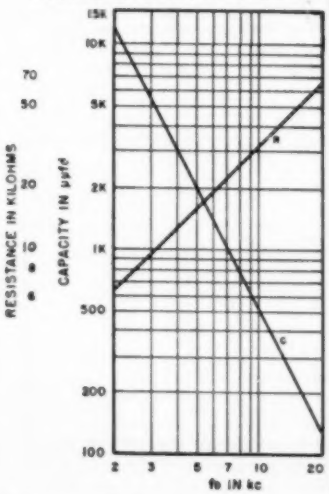
able reluctance cartridge can be used to form a low-pass filter.

One of the most common variable reluctance cartridges in use today is the standard impedance *General Electric* pickup. This unit bears the model number RPX-040 or RPX-041 in the single needle version and RPX-050 in the twin stylus type. The inductance of this pickup is specified as 520 millihenrys. With the value of the inductance and of the "Q" both specified, the capacity and resistance required in the filter become a function of the cut-off frequency alone. Fig. 3 is a graph of the capacity and resistance required to form a low-pass filter of the type described, using a *General Electric* pickup. The frequency plotted on this graph is that at which the response passes through zero decibels in the negative direction as shown on Fig. 2. If it is desired to consider the minus 3 decibel point on the curve of Fig. 2 as the cut-off frequency, then f_o of Fig. 3 is 77% of this value.

Only one of the three values, RC, and f_o can be chosen at will; the other two are specified by the relations indicated on the graph of Fig. 3. Since the graduation in commercial condenser sizes is very coarse, the most practical procedure is to choose an available value of capacity which gives a cut-off frequency closest to that desired. Then the resistance required for this capacity can generally be obtained with one or two resistors. The resistance used need be within only ± 15% of the value specified on the graph to retain the desired cut-off characteristics in the filter.

One important point which must be

Fig. 3. Graph used to determine capacity and resistance required to form a low-pass filter. See text for all details.



noted is that the distributed capacity of the shielded lead and the input capacity of the preamplifier must be added to the value of any additional condenser which is used, to obtain the total capacity.

An example will best illustrate the procedure to follow. A low-pass filter is to be designed with a cut-off frequency of about 7 kc. The phonograph uses a *G.E.* model RPX-050 cartridge and there is 4 feet of shielded phono lead between the cartridge and the preamplifier. The preamplifier is the NPX-003 built by *General Electric*, using a 6SC7 tube.

The common type of brown cloth-covered phono lead has a distributed capacity of 80 $\mu\mu$fd. per foot, resulting in 320 $\mu\mu$fd. of capacity in the cable. The input capacity of a 6SC7, including the Miller effect, is about 60 $\mu\mu$fd. Thus, there is 380 $\mu\mu$fd. of capacity already existing at this point. Fig. 3 shows that 995 $\mu\mu$fd. of capacity is required for a cut-off frequency of 7 kc. Then a 615 $\mu\mu$fd. condenser would be required. Using a 500 $\mu\mu$fd. unit would give a total capacity of 880 $\mu\mu$fd. This together with a 25,000 ohm resistor would then result in a filter with a cut-off frequency of 7.5 kc. and the correct Q.

A tap switch may be used to switch various resistor-condenser pairs across the input of the preamplifier to provide several cut-off frequencies. A continuously variable filter would be rather difficult to build since the resistance and capacity must be varied at the same time and the resistance must be inversely proportional to the square root of the capacity to maintain the proper value of Q.

To obtain the highest cut-off, no additional condenser is used. A resistor of the value specified in Fig. 3 for the shunt capacity of the cable and preamplifier is used alone.

The previous example also indicates why excessive noise results when a high resistance on the order of 50,000 to 100,000 ohms is used at the input of the preamplifier. The Q of the circuit is greater than one and there is a peak in the response, which increases the noise level.

If it is desired to build a record player which has an extended high frequency range, the shunt capacity of the cable and preamplifier must be maintained below the value indicated in Fig. 3 for the range desired. The system used in the example, with 380 $\mu\mu$fd. of shunt capacity, has a limit of 11.4 kc. when a 33,000 ohm resistor is used alone as the input of the preamplifier. Increasing the resistor would not materially extend the range, but only increase the response at 11.4 kc., as shown in Fig. 2.

The three steps which should be taken to minimize the shunt capacity of the system, if it is desired to extend the high frequency response, are:

1. Minimize the length of cable from pickup to preamplifier.
2. Use a low capacity cable, such as *Belden* #8401 mike cable, between the turntable and the preamplifier.
3. Use a dual triode preamplifier which obtains its equalization by negative feedback from the second plate to the first cathode This type of a preamplifier has a low input capacity over the upper audio frequency range. —30—

Within the Industry

(Continued from page 28)

tative organization. His new offices are in the Pure Oil Building in Chicago . . . **MURRAY WEINSTEIN**, well-known consulting engineer in the electronics industry, is now associated with *Regal Electronic Corp.* of New York . . . **T. Y. HENRY** is the new division manager of *Copperweld Steel Company's* new subsidiary, *Flexo Wire Company* of Oswego, N. Y. . . . **AARON LIPPMAN** has been appointed chairman of the 1952 NEDA Convention. He has long been prominent in NEDA activities and is presently serving as chairman of the board . . . *Jewel Radio Corporation* has named **HERMAN N. LUBET** to the dual post of advertising manager and export manager of the firm . . . **MAURICE HARP** has joined the engineering staff of *Lenkurt Electric Co.*, San Francisco . . . **MARTIN L. SCHER** is the new national sales manager for the *Emerson Radio and Phonograph Corporation* line of radio and TV products.

• • •

C. J. LUTEN has been appointed editor of "Sylvania News" succeeding Robert A. Penfield as editor-in-chief of the service dealer publication. Mr. Penfield has been promoted to the position of advertising and sales promotion supervisor.

Prior to joining the advertising department of the company in July of last year, Mr. Luten served as assistant director of educational advertising to *The Ronald Press Company* of New York. He formerly edited the houseorgan for the *W. T. Grant Company* and prior to that was a reporter for the *Dallas Times-Herald*.

—30—

PROPOSED CHANGES IN AMATEUR REGULATIONS

AT THE present time there are four separate proposals before the FCC requesting changes in the Amateur regulations. The first three proposals concern the Amateur frequency band from 7000 to 7300 kc.

A proposal by the ARRL requests that the portion of the band from 7250 to 7300 kc. be opened to permit frequency shift keying (type F-1 emission) for radio printer operation. An additional petition by Robert H. Weitbrecht requests that frequency shift keying be permitted on all amateur frequencies below 27 mc.

A petition filed by the National Amateur Radio Council requests that amplitude modulated telephony (type A-3 emission) be permitted in a 100 kc. section of the 7000-7300 kc. band.

The ARRL has also petitioned to authorize narrow band frequency or phase modulation in the segments from 3800 to 4000 kc., and 14200 to 14300 kc.

—30—

V.T. Keyed Transmitter

(*Continued from page* 41)

on 160 meters, the 6AC7 stage on 80, the 6AQ5 stage on 40, and the final on 40 or 20 meters, the key should be closed. The positive test lead of a high resistance voltmeter should be grounded to the chassis, and a 2.5 mhy. r.f. choke should be placed in the negative lead to read grid drive to the 6AQ5 and to the 807's. Approximately 40 volts of grid drive should be present on the grid of the 6AQ5 and 60 should be measured on the grids of the 807's. Of course, these figures will vary with different loading and bands but they should not vary greatly. With plate voltage applied to the final, from 55 to 60 volts of drive to the 807's should be obtained with careful adjustment of the preceding stages.

The 47 ohm resistors in the grids of each of the 807's are to prevent parasitics. Also, the chokes, RFC_5 and RFC_6, are 47 ohm resistors wound with 7 and 9 turns respectively of #20 s.c.e. enamel.

After preliminary tuning adjustments have been made, say for forty meter output, the oscillator should be heard only faintly with the key up, if it is on 160 meters. Switching the receiver to 80 will increase the volume of the oscillator in the receiver, but still not enough to be bothersome when listening on the transmitting frequency. On 20 and 10, it will not be heard at all. If the oscillator is operating on 80 meters instead of 160, a slight increase in volume will be noticed on 40 and 20, but no signal should be heard on 10 with the key up.

Checks on keying should be made on the 20 and 10 meter bands to determine the keying characteristics. Needless to say, they will be practically perfect on any band with this system. The keying current, measured at the key, should be very close to one tenth of one milliampere. There should be no noticeable chirps whatsoever on 10 meters.

A "fone-c.w." switch is used, as shown in Fig. 2, with W6CXM's modulator as described in the September 1950 issue of RADIO & TELEVISION NEWS. The reader is advised to investigate this compact, useful method of modulation before building a modulator of any kind. The "fone-c.w." switch grounds the speech tube filaments, placing the modulator in operation, connects the 6SQ7 audio output to pin 5 of the 6Y6, and removes the ground from pin 8 of the 6Y6, when it is thrown to the "fone" position. In the c.w. position, it reverses this procedure, connecting the 6Y6 grid to the grids of the 807's through the 2.5 mhy. r.f. choke. For phone operation, the 25,000 ohm, 25 watt screen resistor will have to be adjusted for correct screen voltage.

REFERENCES

Goodman, Byron: "Improved Break-In Keying," QST, March 1948.

—30—

Winding Machines

(*Continued from page 45*)

Kovar, a special alloy selected for the job because it has the same coefficient of expansion as has glass. The big problem in assembling the tubular container was, initially, to solder the *Kovar* rings to the open ends of the case. Conventional soldering was slow and costly and caused occasional mechanical damage. Finally, high-frequency soldering equipment was developed that does the job neatly and quickly. The assembled end of the condenser, with a ring of very thin rosin core solder resting on the *Kovar* ring, is simply placed in an open U-shaped induction loop of water-cooled copper coil. Fed by a three-kilowatt r.f. power oscillator working on about three megacycles, this one-inch loop induces a heavy current in the solder and the end of the metal case and, as if by magic, the solder melts and seals the *Kovar* ring to the case.

The pigtail leads pass through tiny *Kovar* bushings in the center of the glass discs. These bushings, as yet unsealed, act as breather holes and permit the condenser unit to be vacuum processed, that is, all air and moisture are withdrawn and any free space inside the container is filled with impregnating compound. The wires are then sealed to the bushing with specks of solder applied with a midget iron, and the condenser is finished except for marking, exhaustive test procedures, and final inspection and packaging prior to shipment.

—30—

Television scientist Dr. Allen B. Du Mont (left) receives a citation from Mayor Morris Pashman of Passaic, New Jersey for "continuous pioneering, development and inspired leadership in the art of television and electronics." Dr. Du Mont received the award on November 14 at special ceremonies marking adoption by the city of the official slogan, "Passaic, Birthplace of Television." The scroll was signed by New Jersey's Governor Alfred E. Driscoll. Thomas E. Prescott, president of the Passaic Chamber of Commerce and Mayor Pashman.

What's New in Radio

(Continued from page 91)

crystal breakage from rough handling and when changing the needle.

The new unit is furnished with the tiny condenser harness in position on the terminals. Installed in that manner, output is low. Slipping off the condenser raises the output.

The range of the new cartridge is to 5000 cycles. Minimum needle pressure is one ounce and the weight of the cartridge is 19 grams. The housing is of stamped steel.

HIGH VOLTAGE TUBULARS

Aerovox Corporation of New Bedford, Massachusetts currently has available a new line of universal high voltage tubular ceramic condensers which have been especially designed for service and experimental work.

The Type SI-TV units are of the "Hi-Q" brand and are available in eleven capacitance values from 4.7 to 47 $\mu\mu$fd. but at a single 6000 volt rating.

These units come packed five to a carton and are currently available from the company's jobbers.

BEAM POWER AMPLIFIERS

Precision Electronics, Inc., 641-643 Milwaukee Avenue, Chicago 22, Illinois, has published a new brochure describing its line of beam power amplifiers designed and engineered to provide high performance and simple operation with a minimum of maintenance.

Six units are included in the line, a ten watt amplifier (Model G-10); a fifteen watt unit (Model G-15); the Model G-30, a thirty watt amplifier; the G-45, a forty-five watt model; a seventy-five watt unit (Model G-75); and the Model G-30MP, a thirty watt mobile unit.

All of these units are housed in durable cabinets which are suitable for installation in stores, offices, factories, clubs, ballrooms, auditoriums, or outdoor arenas. Catalogue No. 5551, available from the company, carries complete specifications on these amplifiers.

SHORT-WAVE RECEIVER

The Hallicrafters Company, 4401 W. Fifth Avenue, Chicago 24, Illinois has recently introduced a precision built short-wave home radio set which will retail in the moderate price class.

Tradenamed the "Continental," the set with its short-wave band marked with the names of the most popular foreign stations is housed in a plastic case which comes in five decorators' colors (smoky black, air force blue, dove grey, sandalwood, and forest).

PLUG BASE

Industrial Devices, Inc., Edgewater, New Jersey is in production on a new plug base that is said to offer many advantages to the manufacturer employing it in assemblies.

The new unit is manufactured for condensers of the Type CE50 series, fitting a standard medium octal socket. It is suitable for use in condensers made under JAN-C-62 specifications and carries the manufacturer's designation of Model #1800.

The use of nylon gives the unit a toughness which reduces breakage to a minimum while being assembled to metal cans or other related parts. Due to the high strength of this material it has been possible to hollow the unit to a great extent thus making it lighter and creating a savings in material.

TAPE MECHANISM

Tape Master, Inc., of 13 W. Hubbard Street, Chicago 10, Illinois, has announced the availability of a new tape transport mechanism, the Model TH21, and a matching preamp-bias erase oscillator.

The mechanism operates at a tape speed of 7½ inches-per-second and incorporates both fast forward and fast rewind, single switch control, an oversized motor, and practically vibrationless operation.

The companion preamp unit, Model

PA-1, is fully wired and incorporates a push-pull bias-erase oscillator-full monitoring, inputs for both radio-phono and microphone, outlets for amplifier and headphones, complete master switching, and a neon recording level indicator.

A data sheet giving full details on both of these units is available on request.

NEW SOLDER

Kester Solder Company, 4201 Wrightwood Avenue, Chicago 39, Illinois is currently in production on a new and highly active resin flux, known as "44" resin.

According to the company, the new product melts, wets the metal, and flows or spreads all in one instantaneous action with such speed that it is impossible to distinguish the separate actions.

The "44" resin is non-corrosive and electrically non-conductive. It conforms with Army-Navy-Air Force specification MIL-S-6872 (AN-S-63) and the U. S. Air Force specification No. 41065-B-Method 31, in addition to Federal specification QQ-S-571b.

Bulletin No. 444 giving complete information on this new product is available on request.

OUTPUT TRANSFORMERS

Acro Products Co., 369 Shurs Lane, Roxborough, Philadelphia 29, Pa., has recently introduced a new line of out-

put transformers which have been especially designed for use in "Ultra Linear" amplifier circuits.

These new transformers, in the newly developed circuit arrangement, permit lower distortion and wider bandpass than hitherto available in audio power amplifiers.

These "*Acrosound*" units provide full rated power throughout the audio spectrum and have frequency response ± 1 db from 10 to 100,000 cps. They have a ratio of shunt inductance to leakage reactance in excess of 15,000 to 1 and feature precision winding of better than .5% accuracy.

Information on "Ultra Linear" circuitry and the new line of transformers to be used in "Ultra Linear" amplifiers is available from the company on request.

—30—

Spot Radio News
(*Continued from page* 18)

keted along with black and white sets, using standard types of components whose metallic content would be nominal and not enough to interfere seriously with any material-allocation schedules.

COLOR'S FOREMOST ADVOCATE, *FCC* headman Wayne Coy, viewing the stop-production order as a sort of victory for industry, declared in an address before the *National Assocation of Educational Broadcasters* in Biloxi, Mississippi, that ". . . Mr. Wilson did not need to address his letters to other manufacturers inasmuch as they, by a common pattern of ridicule and a lack of selling efforts and promotion of color in television, had decided that the American public should not have the opportunity to enjoy color television except on a basis and at a time to be determined by the industry.

"Notwithstanding the stoppage," he said, "it was felt that . . . color cannot longer be kept underground as it has been for many years by the recalcitrance of those who put their private interests ahead of public interest."

THE RADIATION LAW, recently passed, which provides for the control of transmissions to eliminate any possibility of the use of signals for alien aircraft homing, will operate under the guidance of an advisory group of broadcasters who will cooperate with the *FCC*, designated by the new law as the enforcing agency.

In the new legislation, which became a part of the Communications Act as an amendment, the President will have the authority, in the event there exists war or a threat of war, or a state of public peril or national emergency, to close down ". . . any station for radio communication or any device capable of emitting electromagnetic radiations between 10 kilocycles and 100,000 megacycles which is suitable for use as a navigational aid beyond five miles . . . and see that the equipment is removed,

if necessary, providing just compensation to the owners. Those who violate the law will be subject to stiff penalties." Specifically, the amendment declares that those who are found guilty will ". . . be punished . . . by a fine of not more than $1,000 or by imprisonment for not more than one year or both, and if a firm, partnership, association of corporation, by fine of not more than $5,000." Those who violate the law ". . . with intent to injure the United States, or with intent to secure an advantage to any foreign nation shall upon conviction . . . be punished by a fine of not more than $20,000 or by imprisonment for not more than 20 years, or both."

THE SHIFTING OF FREQUENCIES by broadcasters to confuse enemy aircraft trying to use the signals for homing, proposed in a master plan several months ago to industry, was tried recently during the early morning hours with extremely successful results. In a joint effort of about 400 stations in nineteen states located on the eastern seaboard from Maine to Virginia, and as far west as portions of Illinois and Wisconsin, plus the Eastern Air Defense Force as well as the FCC, the deception plan featured a shift in frequencies in different locales every half minute or so. Direction finders in aircraft trying to glide in on a particular broadcast beam acted quite queerly, since they danced all over the dialplate.

The intriguing plan, which it was said originated in Great Britain, would also call for all elimination of station breaks or call-letter announcements to confuse further any alien aircraft seeking to home in on the beams.

COMMUNITY TV, in a new form, using common-carrier microwave links, recently found its way to the desks of the Commission in Washington. In an application filed by *J. E. Belknap and Associates* of Poplar Bluff, Missouri, a request was made for a system which would permit relaying of TV signals between the Memphis and Missouri communities of Kennett and Poplar Bluff, using frequencies of 5925 and 6425 mc.

In this novel approach to the distribution of signals to DX areas, the video programs of WMCT would serve as a feed, with a two-channel pickup chain employed for beaming signals to a point 75 miles northwest to Kennett and from that site to Poplar Bluff, 40 miles away. Other cities en route were indicated as possible signal sharers, with cities as far north as Cairo, Illinois and Paducah, Kentucky suggested as other points to which signals might be focused. Should the plan work out, the signals of KSD-TV may be used in another route scheme, providing service to Mt. Vernon, Benton, DuQuoin, West Frankfort, Johnson City, Marion and Carbondale, Illinois.

The application revealed that distributors of sets would be asked to pay $5000 upon the installation of 100 chassis, plus $25 per receiver up to 500

units and then $10 a set for between 500 and 1000 sets. There would be no further charge for more than 1000 sets. In addition, service charges were proposed; $1.75 per month for each set up to 500, $1 for 500 to 1000 chassis and 75 cents thereafter. No rates were established for the distributor-to-consumer charges, nor was any plan offered on the methods which might be used to affect distribution of the community-type pickup receivers.

In judging the virtues of this plan the Commission will be obliged to consider the status of the community systems already installed, which simply pick up signals on a high-gain antenna, amplify them and pipe them to sets in the surrounding country for a fee. Although no transmission is involved and coax serves as the feedline from antenna to each set, the service was said by some to come within the common-carrier scope since fees were paid by the individual set operators. Also to be considered are the possibilities of new stations which might be installed around the proposed receiving sites for the v.h.f. or u.h.f. bands. The remote links might be viewed as a competitive media, restricting the listening appeal of the new stations and thus endangering their economic standing. In view of the allocation angle, it may be necessary for the Commission to ask for a hearing or review their assignment proposals in the southern areas. It may also be necessary to introduce rules which will provide for expanded receiving areas produced either by coax or the microwave type of community TV.

TWO PROPHECIES, offered by a pair of government's outstanding specialists during an industry meeting in Washington in the early winter months, disclosed that '52 might not be as blue a year as many forecasted earlier.

In one prediction presented by Curt Plummer, the FCC's Broadcast Bureau Chief, it was indicated that the freeze would definitely be lifted by April and that about 80 stations would shortly thereafter receive their permits to go on the air, with about fifty per cent receiving ultra-high authorization and fifty per cent low-band approval. Industry experts declared that there were enough transmitters in stock, or being made, to permit some of these to go on the air before the close of '52.

The second crystal-gazing statement, issued by Ed Morris, Chief of the Electronics Section of the *National Production Authority*, disclosed that around 4 million television sets would be produced in '52, and production of several hundred thousand sets may be for the new markets created by very-high and ultra-high stations which might go on the air before the end of the year. There should be sufficient material available for the manufacture of these chassis, Morris pointed out; the peak of military requirements occurring early in '52 and leveling off to a plateau stage for the remainder of the year.

The January-to-April period will probably be the most critical of the new year and may frighten many, it was said. Those who are able to carry on during this time should find the remaining eight months good ones for business on the domestic front, according to the Washington timetable.

THE PROGRAM PURGE campaign, described briefly in these columns in '51 and noted as having flared soon after the Benton measure which suggested a citizens' advisory committee to blue-book programs was proposed in Congress, has resulted in several striking developments, particularly the industry code which many have indicated should solve the problem.

Commenting on the broadcasters' policing plan, FCC chairman Wayne Coy declared that it may work, if it ". . . is enforced and it is flexible enough to meet changing conditions."

In a blistering attack on the programs as they are still being produced, Coy said: "The obscenity on the TV screens is getting worse. I am not a prude, and there may be a place for off-color jokes, but there are not for the television screen." Noting that people are concerned about what the children see on the screen, Coy added ". . . The mail at the FCC grows and the protests get louder and louder."

The advisory group, as suggested by the Benton bill, could evaluate program material and see that listeners and viewers are getting their dollar's worth ". . . out of what the FCC is allocating to broadcasters . . ." noted Coy.

In the meanwhile, the *Association of Radio and Television Broadcasters* notified all its members that they should comply with the code which was quite a rigid affair. In a section on acceptability of program material, the code declared that ". . . profanity, obscenity, smut and vulgarity are forbidden, even when likely to be understood only by part of the audience. From time to time, words which have been acceptable, acquire undesirable meanings and telecasters should be alert to eliminate such words. . . . Exhibitions of fortune-telling, astrology, phrenology, palm-reading and numerology are not acceptable. . . . Criminality should be presented as undesirable and unsympathetic. The condoning of crime and the treatment or the commission of crime in a frivolous, cynical or callous manner is unacceptable. . . . The use of visual or aural effects which would shock or alarm the viewer, and the detailed presentation of brutality or physical agony by sight or sound are not permissible."

If this code, based in part on the code used by the motion-picture industry, is adhered to honestly by all stations, not only by those who belong to the association, the Benton bill and other bureaucratic measures will certainly vanish. But if the self-policing fails, the government will surely begin to patrol the screen. . . . . L.W.

International Short-Wave

(*Continued from page 57*)

1215A. (Pearce and O'Sullivan, England)

Albania—Tirana, 7.825, noted 1605 with music; news 1615. (Harris, Mass.)

Algeria—Radio Algerie, 9.57, Algiers, noted after KWID leaves the air, 1745-1800 sign-off. (Maurice, N. Y.)

Anglo-Egyptian Sudan—"Huna Omdurman" noted with fine signal, in clear, opening 2315 on 9.74A; QRM developed and signal faded somewhat by closedown 2145; all-Arabic speech and music. (Fargo, Ga.) The 17.944A outlet noted in South Africa 1130-1300 and 1400-1430, and on Fridays with *English* at 1230-1300. (Ridgeway)

Angola—CR6RP, Radio Clube do Cuanza Sul, Novo Redondo, is operating on 4.932 at 1300-1500, with 200 watts; CR6RK, Radio Clube do Sul de Angola, Lobito, is broadcasting 0600-0730, 1130-1400, and 1500-1700 on 7.180 with 75 watts. (*WRH Bulletin*)

Radio Clube de Angola, Luanda, 9.64, is heard in "morning" session opening 0115; plays recordings mostly; also is using a 41-m. channel but that one is not being heard at the time this report was made. Radio Clube de Huambo, Nova Lisboa, sent verification; said its transmitter is a 1 kw. job made in Brazil; that hopes to broadcast a French and *English* program shortly; is heard well in South Africa from 1330 to closedown 1530; has music-box interval signal; noted on 9.705 in parallel with 7.11. (Ridgeway, South Africa)

Argentina—LRT, 11.840, Tucuman, noted good strength around 1730. (O'Sullivan, England) LRA, 17.720, Buenos Aires, heard in *English* talk 1315-1325. (Sutton, Ohio)

Australia—VLM4, 4.9175, Brisbane, signs on 0245; news 0600, good level; VLX4, 4.8975, Perth, also has news 0600. (Saylor, Va.) VLI6, 6.09, Sydney, heard as early as 0230; formerly signed on 0300. (Balbi, Calif.) VLR6, 6.150, Melbourne, noted around 0310 at excellent level in Calif. (Winch)

Austria—Radio Sweden says the Blue Danube Network, Salzburg, is now using 6.055, 5.080, and 9.617. Noted by Pearce, England, on 9.617 with news 0115; on 6.065A at 1045 with music, call 1100.

Radio Wien, 11.784, Vienna, heard with recordings 0215. (Pearce, England)

Azores—Ponta Delgada, 4.845, noted with news in Portuguese now 1730. (Pearce, England) The 11.090 channel noted on winter schedule 1500-1600. (Ferguson, N. C., others)

Balearic Islands—Menorca, 7.550, is again reported at 1430 and signing off 1630. (*Short Wave News*, London)

Bechuanaland—Mafeking's ZNB operates on *measured* 8.244 at 1200-1430; good strength in South Africa. (Ridgeway)

Belgian Congo—OQ2AB, 11.90, is noted in South Africa at high level; is

scheduled Sundays *only* 0800-1000; all-French; plays recordings; calls "Radio Elizabethville"; opens with Westminster chimes at 0800 and National Anthem. (Ridgeway)

In answer to a listener's question recently, OTC, 9.767, Leopoldville, said it does not use native announcers but that *Radio Congo Belge*, also Leopoldville, has both a male and female native announcer for its native programs. (Bellington, N. Y.) OTM, 9.380 (seems back here from 9.400 now), noted with news in French 1400. (Pearce, England)

Bolivia—Radio Illiamani, La Paz, is operating as CP5 on 5.970 and as CP6 on 9.500 at 0630-0800, 1000-1200, 1630-2200; output for each is 1 kw. (*WRH Bulletin*)

British New Guinea—VLT9, 9.5196, Port Moresby, ends *English* 0200; has short interval of single drum beats, then continues with native commentary. (Russell, Calif.) VLT7, 7.280, noted signing off weekdays 0745, good level in West Virginia.

Bulgaria—Radio Sofia is currently using 9.705A to North America evenings with its own program at 2000; also relays Moscow's North American (*English*) service at times. (Kelting, N. Y.; Balbi, Calif., others) Is using 6.070 in *English* 1500; in Italian 1515; in French 1530, and in German 1545; seems to have increased power on this channel. (Radio Sweden)

Burma—Rangoon now has an *English* session on 9.543 at 2015-2030; during the 0115-0145 period, 6.035 is added, and is also used at 0915-1015 for *English* period. (Radio Sweden) Has been heard on 4.775 in *English* to 1015 sign-off. (Radio Sweden)

Canada—CBFY, Montreal, noted mornings recently on measured 11.700 with religious program daily 0815. (Ferguson, N. C.) VED, 7.32A, Edmonton, Alberta, noted with news in progress when tuned 0105. (Bellington, N. Y.) Identifies and signs off 0200. (Russell, Calif.) CBNX, 5.970, St. John's, Newfoundland, 300 watts, is scheduled 0600-2230 now except Sat. when National Hockey League is carried to 2245. (Peddle, Newfoundland)

Canary Islands—EA8AB, *measured* 7.517, noted from tuning 1704 to sign-off 1800; heavy QRM, fair signal.

Ceylon—Radio Ceylon is currently operating for India

on 15.120, 11.975, and 7.190 at 2045-0230, 0630-1145. (Radio Sweden) Takes BBC news relay 2100.

Noted on 11.975 at 1125; QRA now is Radio Ceylon, Torrington Square, or P. O. Box 582, Colombo 7, Ceylon. (Kroll, N. Y.)

Chile—CE1190, 11.900, Santiago, noted 2325 with closing announcements in Spanish, march, chimes, and then carrier left the air. (Ferguson, N. C.) CE920, 9.200A, Punta Arenas, heard 2120 with weak level, fading. (Bromley, Ontario)

China—When this was compiled, *Radio Peking* was noted on approximately 10.37 mornings and also evenings (around 1700-2030); news 1700, usually followed by POW messages 1715; the 15.060A outlet is noted in various oriental languages, *no English*, around 1700-2030 sign-off. Another Chinese outlet on 15.175A is noted to after 2000; this one was *measured* 15.1756 by Russell, Calif., at 1900.

Peking's 6.100 outlet noted 0400 carrying the news. (Gay, Calif.)

Colombia—*Radio Nacional*, Bogota, operates weekdays 0955-1400 on 4.955; 1700-2330 on 6.200, 11.680; Sundays 1100-1515, 1800-2315 on 4.955, 6.200, 11.680. HJKH, Bogota, *Emisora Nueva Granada*, is on the air daily 0700-2300 on 6.160, 10 kw.; HJDU, operated by the University of Antioquia, Medellin, is on the air on 4.805 weekdays 1130-1400, 1800-2300. (*WRH Bulletin*) HJAP, 4.931, Cartagena, *Radio Colonial*, noted signing off 2250; HJAE, 4.9695, Cartagena, heard in Spanish signing off 2340. (Russell, Calif.)

Costa Rica—TIPG, 9.62A, noted identifying as "La Voz de la Victor" 1900. (Bellington, N. Y.) TIRH, 6.1533, San Jose, noted to *after* 0100. (Russell, Calif.)

Radio Nueva Alma Tica is a *new* station in San Jose, operating on 6.180 with 3 kw., call is TIGH4; other *new* Costa Rican stations are "La Voz de Costa Rica" on 9.692, 3 kw.; "La Voz del Hogar," on 9.714, 1 kw. (*WRH Bulletin*)

Cuba—COCY was recently *measured* 11.736 at 1020, strong signal. (Ferguson, N. C.) COBL is back on 9.833A again. (Stark, Texas; Machwart, Mich.)

Cyprus—Bellington, N. Y., recently noted Limassol around 2340 tune-in on 6.117A in parallel with 6.167A with Arabic chanting.

Czechoslovakia — CLR4B, 15.320, Prague, noted with news 0715, strong signal; *English* ended 0743; asked for reports and said letters would be acknowledged Sundays 1400. (Ferguson, N. C.) Prague noted on 6.170 with *English* 1400-1430 in parallel with 11.875; found on same channels 1600 with *English*. (Pearce, England) Noted signing on in Czech 2315 on 6.010. (Machwart, Mich.)

Dominican Republic—HISZ, 5.030, is coming in now around 1700. (Saylor, Va.) HI4A, 4.980, Santiago, noted 1715. (Catch, England) HI2A, 9.680, noted recently when XEQQ, Mexico, was very weak on that channel; heard 1646 when

man identified as "La Vox de Reeleccion." (Machwart, Mich.)

Dutch New Guinea—Hollandia, 7.125A, noted 0415 with Dutch news, music; good level in Australia. (Sanderson)

Ecuador—HC1T2, Salinas, *Radiodifusora Costa*, is on 6.230 with 300 watts. (*WRH Bulletin*)

El Salvador—YSO, 7.3144, San Salvador, noted in Spanish 2015, music. (Russell, Calif.) YSR, 6.050, San Salvador, broadcasts 1100-0100; YSUA is on 6.250 daily 0700-0000. The short-wave transmitter of *Radiodifusora Nacional*, San Salvador, is off the air due to damage by fire. (*WRH Bulletin*)

Fernando Po—Construction of the "super-powered" *Radio Atlantica* has been delayed indefinitely. However, by this time an "improved" transmitter may be on the air; has been operating with low power on 7.200. QRA is P. O. Box 195, Santa Isabel, Spanish Guinea, West Africa.

Fiji—A short-wave transmitter is being built at Suva with power of 500 watts; expected to be ready early this year. (Patrick via ISWC, London)

France—Paris noted on 5.945A at 1500-1745 sign-off; used both French and Portuguese. (Saylor, Va.) Paris, 6.145, still has Gôrman 0130-0145; has Portuguese-French session now 0300-0315 on 6.145 and 7.240. (Bellington, N. Y.) Noted on 11.845 at 2315-2330 sign-off. (Niblack, Indiana) Heard in French on 9.560 at 0030 to *after* 0100. (Crandall, N. Y.) New Paris schedule for *English* broadcasts ("The French Have a Word For It") is 0315-0330 on 7.240, 6.145; 1345-1400 on 7.280, 6.200; Sat. and Sun. 0800-0900 on 7.240. (Pearce, England)

French Equatorial Africa—Radio Brazzaville, 11.970, noted signing on in French 1000. (Ferguson, N. C.) Noted in *English* 1745-1800. (Sams, Oregon; Suarez, Md.)

French West Africa—Radio Dakar, 15.346, noted 1515 with news in French. (Pearce, England)

Germany—Radio Sweden says *Radio Free Europe* is currently using 6.020, 6.095, 6.130, 9.607 (Lisbon), and 11.735.

AFN, 5.470, noted around 1430. *Deutschlandsender Berlin*, 6.115 and 7.150, heard with music 0215. (Pearce, England)

Gold Coast—Accra is scheduled weekdays 0100-0125, 0458-0815, 0943-1300, 1300-1615; Sundays 0100-0815, 0915-1615 (with relays from BBC *only*); frequencies are 4.915, 6.049. Gold Coast time is 5½ hours *ahead* of *EST* from January 1 to August 31. (*WRH Bulletin*)

Greece—Radio Athens, 9.607, noted in *English* 2046, fair level in N. Y. (Hoffman) Noted on this channel 1430 with *English* broadcast. (Pearce, England)

Greenland—Angmagssalik, 7.575, is heard 1630 and closing 1858; identifies with "God Aften her Gronlands Radio." Also reported testing on 12.300, 15.402. (*Short Wave News*, London)

Guatemala—TGNA officials are considering the possibility of using a fre-

quency in the Tropical Band (between 3-4 megacycles) for Spanish transmissions—to effect less spread of the signal to outside areas as well as because of less congestion on that band; has been using approximately 5.952; has received quite favorable reports on reception on the *new* 11.85 channel—used for *English* daily 2200-2230 (extended to 2300 on Wednesdays when last 30 minutes is Mail Bag session) in parallel with 9.668; several alterations and adjustments have had to be made to the *new* 11.85 transmitter. TGNA appreciates reports and will verify *all correct* ones. (Russell, Calif.)

Haiti—4VEH in verifying for Bellington, N. Y., sent this schedule for its 9.710 outlet—*English* daily except Sunday 0600-0630, 0730-0815; Spanish 0630-0730; Sunday schedule is 0630-0700 Spanish; 0700-0830 *English;* 1730-1830 Spanish; 1830-1915 *English;* 1915-2000 Creole; 2000-2030 Spanish; 2030-2100 *English*. Power is still 800 watts and a station official said "it looks like it will be quite some time before we can get on 10 kw." QRA is Box 1, Cap-Haitien, Haiti.

When this was compiled, 4VRW was "on the move" again; noted on 9.870, 9.878, then on 9.96, and still later on 9.24. (Oskay, N. J.; Stark, Texas; Bellington, N. Y.)

Holland—Hilversum now uses 6.025 in parallel with 9.59 to North America weekdays 2130-2210; for "Happy Station Programs" Sundays 2130-2300.

Honduras—HROW, 6.660, Tegucigalpa, noted with good signal around 2200 and later. (Ferguson, N. C.) HRN, 5.870, Tegucigalpa, noted signing off 2230 recently. (Stark, Texas)

Hong Kong—ZBW3, 9.524, noted 0700 with news. (Machwart, Mich.)

Hungary—Saylor, Va., reports Budapest noted signing on 1800 recently on 6.023A; caused QRM to ELBC, 6.025, Monrovia, Liberia.

Budapest is using 6.247A in parallel with 7.220 and 9.833A (has dropped 11.910) for *English* programs to North America evenings (*EST*); takes some relays from Moscow.

India—AIR's External Services schedule received airmail is—*To East and South-East Asia and Australia and New Zealand*—1930-2000, 15.290, 11.850; 2030-2200, 15.160; 17.740; 0200-0330, 21.510, 17.830; 0600-0815; 17.740, 15.190; 0830-0945, 17.740, 15.290. *To Middle East, Central Europe, United Kingdom, Burma, and Philippines*—0200-0330, 21.510, 17.830; 0230-0330, 17.740, 15.190; 0600-0700, 17.740, 15.190; 0830-0945, 17.740, 15.290. *To China, Japan* (Sat. and Sun. *only*)—0530-0600, 17.705, 15.160. *To East and South Africa, Mauritius*—2300-0015, 17.740, 15.160; 1045-1215, 15.290, 11.710. *To West Indies*—1830-1930, 15.290, 11.850, 9.575, 7.170. *To Burma*—1945-1955, 11.710, 9.720; 0615-0700, 21.660, 15.160. *To China*—0430-0545 (to *only* 0530 Sat., Sun.), 17.705, 15.160. *To Indonesia*—1745-1800, 11.790, 9.720; 0700-0730, 21.660, 15.160. *To East and South-East Asia*—1930-2000, 15.290, 11.850; 2030-2200, 17.740, 15.160; 0200-0330, 21.510, 17.830; 0600-0815, 17.740,

15.190; 0830-0945, 17.740, 15.290. *To Fiji*—0200-0330, 21.510, 17.830. *To West Pakistan*—2245-2300, 11.850, 9.590, 7.120, 6.150; 0945-1000, 5.970, 4.940. *To Afghanistan*—2215-2230, 9.620, 7.225; 0030-0130 (Fri. *only*), 9.565, 7.225; 0845-0930, 4.940; 1130-1230, 9.720, 5.990, 4.940, 3.435. *To Persia, Afghanistan*—1230-1330, 9.720, 7.155, 5.990, 4.940. *To Saudi-Arabia, Egypt, Lebanon, Syria, North Africa, Jordan, Sudan*—2230-2315, 15.210, 11.760; 0000-0045, 17.760, 15.210; 1230-1430, 9.550, 7.125. *To East and South Africa, Mauritius*—2300-0010, 17.740, 15.160; 1045-1215, 15.290, 11.710. *To Europe*—1400-1500, 9.720, 7.170; 0230-0330, 17.740, 15.190. *English* news is at 1400-1410, 9.720, 7.170; 1930-1945, 11.850, 15.290; 2315-2330, 17.740, 15.160; 0300-0310, 17.740, 15.190; 0830-0840, 17.740, 15.290; 1045-1100, 17.740, 15.290.

Indo-China (Vietnam)—"The Voice of Vietnam" in Saigon is broadcasting on three channels now—9.620, 12 kw., 6.180, 1 kw., at 1800-1900, 2300-2400, 0500-0830 in Vietnamese; 0830-0900 in *English*; on 7.090, 12 kw., at 1800-1900, 2300-2400, 0500-0830 in various languages; in French at 1800-1830, 2330-2400, 0615-0730; in *English* at 0800-0830. *Radio Hue, 7.205*, Hue, is scheduled now 1830-1900, 2130-2230, 2300-2345, and 0200-0300, 0500-0730; news in French 2330-2345. (*WRH Bulletin*) Noted on 7.0912 with news 0845. (Russell, Calif.)

Radio France-Asie, 9.754, Saigon, is noted at good level from 0900 to closedown 1030 or 1033; all-French programs, woman announcer; not in parallel with 11.83 which has *English* and bi-lingual programs at 0900-1030 closedown. (Ridgeway, South Africa)

Iran—Teheran, 15.100, still noted with short newscast 1500. (Pearce, England)

Iraq—Baghdad, 11.724, noted with news 1415, good signal at that time (since *Radio Pakistan* leaves 11.726 at 1415); QRM is "terrific" prior to 1415; also has QRM from Hilversum on 11.73. (Ridgeway, South Africa) Normal closedown is 1500. (Radio Australia) Noted in Arabic 0100. (Bellington, N. Y.)

Israel—Tel-Aviv, 9.010A, still noted in *English* to 1700A sign-off. (Alcock, Ky.)

Italy—At the time this was compiled, Rome was making several frequency changes. Heard signing on 0300 on 9.575, 11.81. And on 7.11 with Portuguese at 1615. (Bellington, N. Y.) Noted calling Great Britain-Ireland in *English* 1350-1435 on 6.010, 9.575. (Pearce, England)

Italian Somaliland—Short Wave News, London, says an experimental station is operating from Mogodishu on 7.420 at 1200-1300; all programs are in Italian and consist of Italian music, songs, and news; opens and closes with announcement "Transmette Mogodishu. . . ."

Jamaica—Radio Jamaica, 3.360, noted signing off 2301 with "God Save the King." (Machwart, Mich.)

Japan—JO8G, 6.0053, Tokyo, noted around 0115. (Russell, Calif.) AFRS,

Tokyo, noted on 9.605, 11.825 at 0150 with music. (Bellington, N. Y.) "Voice of the United Nations Command," Tokyo, heard opening 0655 on 6.015 in *English;* announced 7.257 and 9.505 as parallel; runs to 1000 sign-off. (Rosenauer, Calif.) BCOF, 6.105, Kure, sent interesting card; said 1470 kc., 200 watts, and s.w. 6.105, 1 kw., operate daily 1630-0900. (Dary, Kans.)

Kenya Colony—Nairobi, 4.855, has local news 1315. (Pearce, England)

Korea (South)—HLKA, 7.934, has been heard at fair strength around 0630 lately. (Radio Australia)

Labrador—VONW, Northwest River, shares 3.480 with a *new* station at Nain, Labrador, on irregular schedule; low-powered. (Peddle, Newfoundland)

Lebanon—Saylor, Va., reports Beirut noted on 15.600 with a French program at 1335; fair level. Ridgeway, South Africa, notes the 8.036A channel ending *English* period 1100. *English* session begins 1100, says Pearce, England. This outlet is heard in Mass. at 1550 with news in French, signing off 1600, according to Harris.

Malaya—BFEBS, 9.690, Singapore, noted signing off 0615. (Ferguson, Va.)

Martinique—Radio Martinique, Fort-de-France, radiates on 9.700 weekdays 0530-0630, 1115-1345 (Sat. to 1430), 1730-2015 (Sat. 1700-2100); Sundays 0630-0800, 1115-1430, 1700-2015; news in French 0600, 1200, 1900 (relayed from Paris). (*WRH Bulletin*)

Mauritius—Ridgeway, South Africa, flashes that V3USE, Forest Side, is back on its old channel of 15.053A after having tried 11.84 and 12.12 for a short time. It still has QRM although sometimes is good level and in the clear in South Africa. Schedule is weekdays 2200-0015, 0300-0430, and 0930-1230; French news 1045; signs off with "God Save the King"; has French announcements but uses some BBC-transcribed programs for its English-speaking audience.

Mexico—Widely reported of late is XWKW, "Radio Morelia," measured by Russell, Calif., on 6.3017; signs off 2330. Heard from before 1800 by Stark, Texas.

XESC, Mexico City, seems to be operating now near its original frequency of (announced) 15.205; was measured 15.206 at 1005 recently. (Ferguson, N. C.) Had been as high as 15.220A at times.

Monaco—Monte Carlo noted signing off 1745 on 6.035 in French. (Rodger, Scotland)

Mozambique—CR7AA, 11.764, Lourenco Marques, noted starting 2300 in *English;* poor to fair signal; announces "For happy listening from 6 in the morning 'till 11 at night." (Niblack, Indiana) Lourenco Marques is noted by a British listener on 15.270 to 1500 closedown. (Radio Sweden) Heard on 4.920A at 1030-1045 in *English;* weak level. Rosenauer, Calif.) This outlet noted in England 1245 with commercial program. (O'Sullivan)

New Caledonia—Noumea, 6.035, noted in French news 0345. (Saylor, Va.)

Norway—LLM, 15.175, Oslo, noted

0600-0700, 0800-0900, replacing LKV, 15.170; latter is still used afternoons but normally is covered by TGWA. (Legge, N. Y., via NNRC)

Pakistan—The news from *Radio Pakistan* is now being heard 0730 over 7.096A, 7.147A, and 15.620. (Stark, Texas; Boord) *Radio Pakistan* was recently measured on 11.673 at 0850; announced in *English* 0915 and continued with Burmese program. (Ferguson, N. C.) Open 0830 to Burma.

Dacca, 15.620, noted with news 0210-0220; Karachi, 7.010, 11.726, noted with *English* at dictation speed 1210-1230; on 11.675 with news 1015-1030. (Pearce, England)

Panama—HO50, 6.045, Panama City, noted 2330 with orchestral selections; giving slogan of "Transmite Radio Programs Continental" at 0000, with sign-off 0002 after anthem. On another occasion was heard to *after* 0200. (Russell, Calif.) HOQQ, Panama City, *Radio Nacional*, is on 6.140 daily 0700-2200; all-Spanish programs but gives some announcements in English also. (*WRH Bulletin*)

Paraguay—*Radio Nacional de Paraguay*, 6.270, noted to *after* 2030; listed ZPA, 6.275. (Stark, Texas)

Peru—*Radio Nacional del Peru*, 9.560, noted to after 2215; calls given are OAX4A, OAX4T, and OAX4Z. Has bad QRM before 2200; OAX4Z, 5.880A, is in parallel; another night both 5.880A and 9.560 were noted going after 2300. (Stark, Texas) The *measured* 9.5607 outlet is "supposed" to be the *new* 50

(*Continued on page* 146)

WORTH PUTTING ON YOUR WINDOW

A STEP forward towards a better understanding of the serviceman by the consumer was a recent national advertisement by Sprague Products Company. Entitled, "Are Servicemen Gyps?", the ad reflects the anxiety of many consumers towards their local TV servicemen.

In this advertising message to the consumer, Harry Kalker, President of Sprague Products Company, completely belittles the arguments often made against servicemen. Mr. Kalker points out that the people who complain about high priced servicemen are the same ones who accept the excessive charges placed on them by the garageman, the medical specialist and the lawyer. The ad fully states the case of the reputable television technician in the following quote:

> "Servicemen are not fly-by-night businessmen. Ninety-nine out of 100 radio-television servicemen run their businesses properly. The other one per cent—the gyps—can usually be spotted a mile away. Nine times out of ten, they are the shops that feature 'bargain' prices and ridiculously liberal service contracts. And their victims are generally set owners who expect to beat the game by 'getting something for nothing.'"

Giant window size reprints of their advertising message will be sent to you upon request by Sprague Products Company, North Adams, Massachusetts. Enclose ten cents to cover handling and postage. —30—

Beat-Frequency V.F.O.

(*Continued from page 49*)

dial. The dial can contain scales for each harmonically related amateur band and, providing good trimming and tuning condensers are used, can be relied upon for repeat performance. If good frequency standards are available, the unit may be accurately calibrated and employed as a secondary standard thereafter.

The normal output of the v.f.o. was designed to be equal to that of the average crystal oscillator. Where higher output may be desired there is no reason why a cathode follower of higher ouput cannot be employed. Since the ouput impedance of a follower is about $1/G_m$, there is also no reason why the output impedance cannot be changed if desired. The output power of a cathode follower operating class A is substantially 25 per-cent of the d.c. plate input power. Since operation is potential up to the grid of the cathode follower, there are no reactions due to sudden changes in loading such as keying and hence the r.f. regulation of the unit is excellent.

The unit is keyed by simultaneously breaking the cathode circuits of both the adder and cathode follower. Impedance match to the cathode follower is obtained by proper coupling of the small coil attached to the far end of the 300 ohm line to the input tank of the amplifier or multiplier to be used in the following stages of the transmitter.

In normal operation of the station, the oscillators are allowed to run continuously as the power consumed is negligible. The plate voltage of the oscillators only is regulated at 150 volts through use of a 0D3/VR150, as indicated in Fig. 2. Only the simplest kind of power supply is necessary or one supplying unregulated, 300 volts d.c. plate and 6.3 volts a.c. heater supply. With the unit continually warmed up, there is no question about its being instantly available for break-in service at the desired frequency.

In the model described, the panel size was 11½ inches long by 6 inches high. The chassis was 9 inches wide, 6 inches deep, and 2 inches high. Two cans, each 6 inches long, 4 inches high, and 2¾ deep, were used for the oscillators and adding stage. Cans and chassis were constructed from 3/32 inch aluminum.

The design of this model does not necessarily have to be followed religiously. Now that the circuits have been proven, conventional chassis construction could be used. The oscillator and adder coils could be mounted in individual cans similar to those used for i.f. transformers with the trimmers mounted in the top of each can. The tuning condensers could be mounted above chassis as in conventional receiver design. Tubes could be spaced sufficiently from the coil cans to prevent undue heating of the cans. —30—

Crystal Diodes

(Continued from page 65)

result is substantially the same. The voltage *versus* frequency characteristic for an FM discriminator is shown in Fig. 7. The total voltage output of a discriminator varies in a positive and negative direction depending upon the deviation of the i.f. signal above or below the mean frequency. The greater the frequency deviation the greater the voltage developed.

The output voltage is the algebraic sum of the voltages developed across the load resistors of the two diodes. It should be apparent from the curve shown that if the straight portion of the discriminator voltage frequency curve covers a wider range of frequencies than those generated by the transmitter, the audio output will be reduced from the maximum value of which the receiver is capable. This must be so because at its "center" frequency the discriminator produces zero output voltage. On either side of this center frequency there is developed a voltage of a polarity and magnitude that depends upon the direction and amount of frequency shift from the center frequency.

Therefore, the voltage output of a discriminator varies in precisely the same fashion as the audio voltage which modulates the carrier. The greater the voltage developed across the diode load the louder the sound coming from the speaker. When there is no modulation on the FM carrier there is no deviation of frequency and consequently no audio voltage is developed; hence, no sound comes from the speaker.

But there is an important point to be made in connection with a discriminator detector. The output voltage of a discriminator may vary directly with change in input voltage. The curves marked *A* and *B* in Fig. 7 indicate this fact. This is why a limiter circuit is important. It holds the input level at constant amplitude and does not permit the discriminator to receive signals that are amplitude modulated. The reason why amplitude modulated signals might appear at the discriminator in an FM circuit was discussed before in connection with the limiter, where it was shown that since the response curve is not perfectly flat topped, there is some variation in the signal level which is, in effect, amplitude modulation of an FM signal wave.

The method of conversion of frequency changes into audio voltage is graphically illustrated as a function of the linear portion of the discriminator characteristic, shown in Fig. 8.

The circuit of Fig. 9 is a simple discriminator detector circuit. The better the matching of the diodes the better the performance of this type circuit; but note the remarks in the caption. This circuit will operate over the entire range of commonly encountered i.f. frequencies from the 4.5 mc. used with intercarrier sound to the 44 mc.

i.f. The crystals and associated resistors and condensers may be mounted under the chassis or they may be enclosed in a small shield can. In some instances, by careful layout and design, it is possible to include the diode crystals, resistors, and condensers in the FM discriminator shield can. Such location is important in preventing feedback. This makes a most compact assembly although it does present servicing difficulties.

The circuit shown in Fig. 10 is desirable from the standpoint that crystal matching is not necessary. The 220,000 ohm resistors in parallel with standard stock type 1N48 diodes keep the circuit balanced irrespective of the back resistance of the crystals. The other circuit values are typical of those found in a discriminator circuit. The reverse resistance of a crystal diode is subject to minor variations with changes in ambient temperature, humidity, and impressed voltage. While in general applications the small changes in back resistance are of little consequence they are significant in an FM detector because demodulation depends upon close balance between the two parts of the circuit. The better the balance the higher the degree of linearity and the greater the AM suppression for the discriminator.

The sound circuit of a television receiver is the same as that found in a typical FM receiver. Detection of the i.f. signal is accomplished by a discriminator or a ratio detector circuit. Both types of circuit require two diodes and balanced conditions for optimum operation. Germanium diodes have been successfully substituted for vacuum tube diodes in a discriminator circuit; probably the most widely used discriminator is the Foster-Seeley type. The chief circuit difference for crystals as compared to the vacuum tube is the use of shunting resistors with the crystals to maintain fairly uniform balance between both halves of the circuit with respect to the back resistance characteristics.

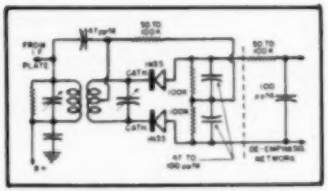


Fig. 9. FM discriminator circuit using germanium diode crystals. The IN35 duo-diode, consisting of carefully matched crystals, is highly satisfactory for this circuit. IN35's are matched in forward resistance only and since this resistance is small compared to 100,000 ohm load, balance is unimportant. The necessary balance is in back resistance which is not very much greater than 100,000 ohms. This is one reason why shunting resistors are suggested in Fig. 10. Use of shunting resistors will permit the use of less expensive IN34 type crystals. The 100,000 ohm resistors and 47 mmfd. condensers should be low tolerance matched components for ideal balance of two parts of circuit. The de-emphasis circuit network is shown only to indicate parts values.

Ratio Detector Circuits

A discriminator detector requires one and preferably two limiter stages because of discriminator sensitivity to amplitude as well as to frequency variations. For effective limiting there must be good amplification of the i.f. signal before it reaches the limiter in order that all signals have a level sufficiently high to operate the limiter at saturation. Since a ratio detector does not respond appreciably to amplitude

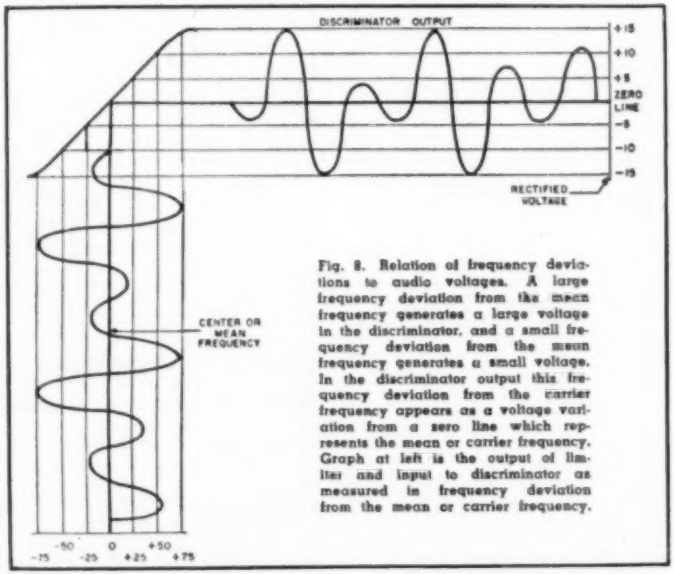


Fig. 8. Relation of frequency deviations to audio voltages. A large frequency deviation from the mean frequency generates a large voltage in the discriminator, and a small frequency deviation from the mean frequency generates a small voltage. In the discriminator output this frequency deviation from the carrier frequency appears as a voltage variation from a zero line which represents the mean or carrier frequency. Graph at left is the output of limiter and input to discriminator as measured in frequency deviation from the mean or carrier frequency.

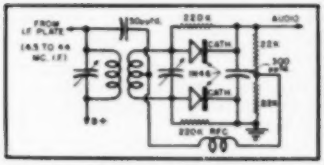


Fig. 10. Frequency discriminator circuit. This circuit performs as well as that shown in Fig. 9 but eliminates the need for using matched diodes by using 220,000 ohm resistors in parallel with IN48 type diode crystals. Circuit is thus balanced regardless of back resistance of diodes. Other component values are typical of those found in a discriminator circuit.

variations it is, from that point of view, superior to a discriminator type detector.

The chief advantage of a ratio detector is that for a weak carrier, on modulation, the voltage ratio is the same as for a strong carrier, on modulation; therefore, the ratio detector is not responsive to carrier changes, and hence relatively insensitive to either sudden or dynamic changes in amplitude of the applied signal. Because a ratio detector is responsive to slow changes in carrier, a.v.c. may be desirable. The audio output deriving from frequency modulation of the applied signal results from the change in the ratio of the two diode voltages which makes the circuit responsive mainly to variations in signal frequency and not to dynamic changes in signal amplitude.

With a ratio detector circuit, balance between the halves of the system is more critical than for a discriminator type circuit. The ratio detector provides AM suppression as well as FM detection and its operation depends, to a great extent, on the balance between the halves of the system. The back resistance of crystals is not uniform and changes with temperature and voltage level; the situation is complicated by the fact that the changes are not likely to be the same in both diodes, nor to occur at the same time.

It is therefore more difficult to design a ratio detector system using germanium diodes, but it is not impossible. Variations of the ratio detector circuit have been designed to minimize any detrimental and undesirable effects of the back resistance characteristics of the crystals. Although these circuits do not achieve all the good inherent in the ratio detector system, they do approach the operating quality of conventional vacuum tube circuits.

The ratio detector has excellent inherent noise and AM reduction characteristics, and the conventional circuit using a 6AL5 is economical. But it is not possible to simplify the conventional ratio detector circuit just by inserting germanium diode crystals as substitutions for the separate halves of the 6AL5. The dynamic characteristics of a crystal are somewhat different from those of a vacuum tube diode.

However, experimental work with

the ratio detector circuit has facilitated the development of a crystal diode ratio detector circuit that provides performance data approximately equivalent to that obtainable from a vacuum tube. The crystal diode circuit has excellent physical advantages over the vacuum tube diode with respect to savings in weight, power, and space, making possible the development of battery-operated, portable-type FM receivers.

The ratio detector circuit depends critically upon close balance between the two individual parts of the circuit in order to obtain a high degree of linearity and to provide the amount of AM suppression desirable in an FM receiver. The modified form of ratio detector circuit here presented will yield results comparable to those achievable by a vacuum tube circuit, assuming that both units are properly designed and equally well constructed.

The combined load circuit shown in Fig. 11, has a time constant long with respect to the period of any AM components present and causes the sum of the diode output voltages to remain constant as far as AM components are concerned. Since the sum of the diode voltages is thus fixed by the long time constant load circuit, the ratio detector is not responsive to the dynamic changes in the amplitude of the signal.

The audio output due to frequency modulation of the applied signal results from a change in the magnitude of the two diode voltages, the net effect of which is to make the circuit responsive only to variations in signal frequency and not to dynamic changes in signal amplitude. Thus AM components due to noise and multipath transmission effects are largely suppressed in the ratio detector.

To obtain maximum suppression of amplitude variations in the output of the ratio detector, it is essential that the two halves of the circuit be balanced and remain so throughout the entire dynamic range of the input signal. This requires close tolerances in the resistance and capacitance values and careful design of the input transformer primary, secondary, and tertiary windings, as well as close matching of the diode characteristics. The close matching of the diode characteristics is most critical; for this reason it is generally necessary to supplement the ratio detector with some means of AM reduction before the ratio detector stage. In this one respect crystals have some superiority over vacuum tube diodes. Additional details on this point will be given later.

Many attempts to substitute crystal diodes for vacuum tubes in the conventional ratio detector circuit have been unsuccessful, in that little or no AM reduction was obtained, and the circuit itself proved to be unstable both with respect to symmetry of detector characteristic and permanency of alignment. However, with suitable modification of the basic circuit arrangement the undesirable effects of the variations in the back resistance

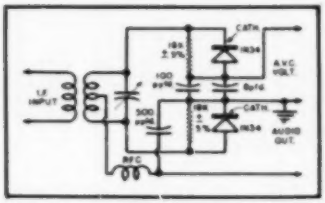


Fig. 11. Crystal diode shunt ratio detector.

of the crystal can be largely eliminated, and a germanium diode ratio detector exhibiting the characteristics of the vacuum tube diode circuit can be designed.

Modifications from the conventional type ratio detector circuit are relatively minor, as can be gathered from a consideration of the modified shunt ratio detector circuit shown in Fig. 11. The load resistors for the crystals are shunt rather than series connected. Electronically, the shunt circuit is equivalent to the series circuit in that, for given values of load resistance and signal voltage, the rectification efficiency is essentially the same for both.

Shunt connection of the crystal diodes makes possible the use of resistances in parallel with the crystals, each of which is of much lower value than the back resistance of the crystal across which it is connected; these resistances have the effect of swamping out the crystal back resistances. This detector circuit is relatively insensitive to changes in crystal back resistance and tends to reduce static and dynamic imbalance between the halves of the circuit. By virtue of their high conductance, crystals tend to provide somewhat improved circuit efficiency over vacuum tube diodes. Low shunting resistors, however, reduce efficiency as compared to vacuum tubes. Diode balance or AM suppression can only be obtained at the expense of output.

There are numerous advantages to be gained by using crystal diodes to replace the vacuum tubes in this type of circuit:

1. *Compactness*—The entire assembly can be built into the same shield can as a plug-in device if one is willing to use the *Vector* socket technique. The associated condensers and resistors, in addition to the two germanium diodes, occupy so little space that there is plenty of room to make a complete package unit of the entire ratio detector circuit.

2. *Filament Elimination*—The elimination of heater requirements materially reduces hum difficulties, particularly with series heater circuits, where the potential difference between cathode and heater of a detector tube may be quite large.

3. *Parts Elimination*—This makes for economy in the number of component parts, such as the socket and a smaller size filament transformer, which result in a substantial saving of space and reduction of weight.

4. *Imbalance Elimination*—There is complete elimination of imbalance re-

sulting from contact potential effects in diode elements. Contact potential may upset static balance between the halves of the circuit.

In FM detector circuits that are properly balanced maximum AM suppression occurs at that frequency corresponding to the crossover of the detector characteristic. A crystal circuit is somewhat more susceptible to residual amplitude modulation than a 6AL5 duo-diode circuit.

The load resistance in a crystal type ratio detector circuit has some effect upon circuit sensitivity as well as upon AM reduction. *Sensitivity* as used here indicates the ratio of the d.c. voltage across the holding condenser to the r.f. voltage across the secondary of the input transformer.

On the basis of experimental curves showing circuit performance with load resistances varying from 5000 to 50,000 ohms, it has been found that the circuit is most stable when the load resistance is kept small with respect to the back resistance of the crystals. Values from 15,000 to 20,000 ohms are a nice compromise among the variety of factors which obtain.

In some respects a crystal circuit is superior to a vacuum tube circuit for AM suppression, but for an off-tune signal, background noise is quite likely to be greater. On the other hand, a crystal circuit is simpler to align than a vacuum tube circuit, by virtue of elimination of contact potential imbalance effects.

A ratio detector circuit may be adjusted for virtually any pair of crystals, but the AM reduction will vary from pair to pair, because of the degree of variability in the dynamic forward characteristics. With random selection of crystals an AM reduction factor of about 0.025 is possible, while with careful selection of crystals matched for similar forward dynamic characteristics the AM reduction factor is better than 0.010.

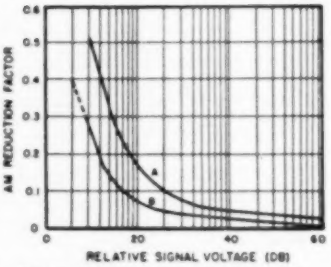


Fig. 12. Effect of single crystal diode dynamic limiter on AM reduction factor for shunt crystal diode ratio detector. (A) Crystal diode ratio detector only. (B) Crystal diode ratio detector and dynamic limiter.

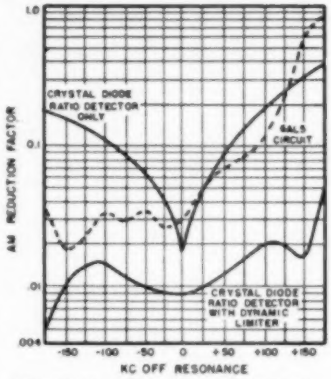
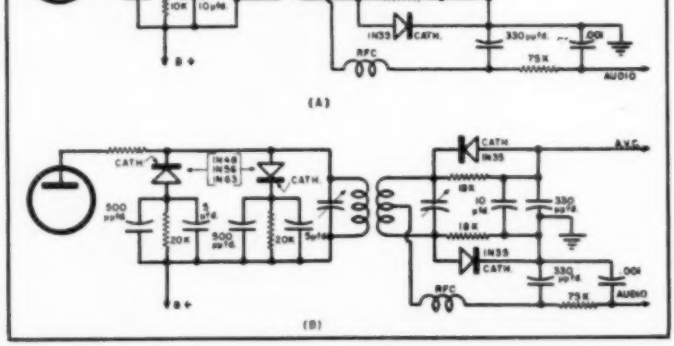


Fig. 13. The effect of a single diode dynamic limiter on the AM reduction factor over entire band of operating frequencies.

Whenever it is desirable to achieve a degree of AM suppression comparable to that achieved by a vacuum tube grid bias limiter, a circuit involving a crystal diode dynamic limiter just before the ratio detector stage is indicated. In addition to providing a sub-

Fig. 14. Dynamic limiter and ratio detector with (A) single and (B) double diodes.



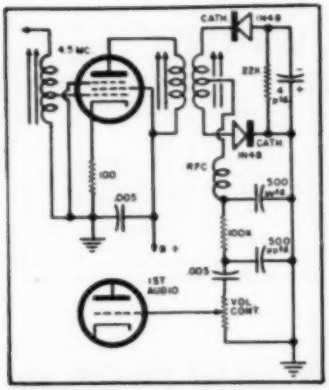


Fig. 15. One manufacturer's commercial adaptation of a ratio detector circuit.

stantial degree of AM suppression in itself a dynamic limiter tends to minimize the necessity for AM suppression by the ratio detector.

In such a combination germanium diode circuit crystal selection may be eliminated in the ratio detector stage. This is because a dynamic limiter extends AM suppression to lower input signal levels and over a wider frequency deviation range from the mean signal frequency. Fig. 12 and Fig. 13 show the AM reduction factor as a function of signal level both with and without the dynamic limiter.

In summary, then, a crystal diode shunt type ratio detector combined with a crystal diode dynamic limiter will provide an audio output comparable to that obtainable with the conventional duo-diode tube ratio detector of the 6AL5 type. A suggested circuit is shown in Fig. 14.

Fig. 15 shows a commercial application of the 1N48 to a good ratio detector circuit.

(To be continued)

NEW RADIO-RELAY PLANNED

THE Long Lines Department of the American Telephone and Telegraph Company has revealed plans for a radio-relay system to operate between Pittsburgh, Pa. and St. Louis, Missouri.

An existing relay system which now connects Columbus, Dayton, and Indianapolis would make up the central section of the proposed route. When completed, the system, including the Columbus-Indianapolis section, will represent an investment of about 9 million dollars.

The new system would be the second east-west microwave route across the midwest. It will augment cable and wire facilities and will tie-in to the coast-to-coast microwave highway at Pittsburgh.

The new relay system is to have a total of 24 microwave stations. Expected to be ready in mid-1953, the new route will provide, initially, hundreds of telephone message circuits. When fully developed it will provide over a thousand message circuits and several television channels. —30—

Mac's Service Shop

(Continued from page 62)

forming other jobs of mechanical manipulation in very restricted quarters. When working on live receivers, it is a good idea to slip a length of spaghetti over the shanks so that you will not short out anything."

"And don't forget to mumble 'This may hurt a little' before you start using them on a set," Barney advised. "But how about the automobile mechanics? Did they watch you too closely for you to steal any of their stuff?"

"'Borrow' is the word," Mac corrected with a pained expression; "and I did get some tools and ideas at the garage. Notice these three additions to our pliers department: that big, loose-jawed pair is known as water-pump pliers, and they are just the stuff for grabbing hold of a can-type electrolytic and holding it solidly while you unscrew the big mounting nut. For that matter, they are also fine for starting those nuts or for acting as a wrench on any outsize nuts for which we do not ordinarily have an end-wrench. The pliers with the short powerful jaws are called battery pliers, and they are fine for any job where you need some extra leverage. The tiny little pliers are ignition pliers, and they have a dozen uses around the shop. For example, they can be used for loosening or tightening the nuts that hold speaker spiders, for loosening speaker mounting nuts when the bolts are so long that our spintite wrenches will not reach them, or for doing any job where you need to grip something firmly in a space where there is no room for ordinary pliers."

Before continuing, Mac opened a box sitting beneath the bench and revealed a brightly-painted little bench-grinder. "I was shamed into buying this," he said with a grin. "The other night Homer Frank, my favorite garage mechanic, was loafing here while I turned out a few sets. He got to prowling around in the tools and nearly had a fit when he saw our collection of drills, punches, chisels, and screwdrivers, which he insisted was the sorriest lot he had ever seen outside of a toy tool chest! Then he *did* have a fit when he wanted to sharpen them and I told him we had no electric grinder.

"Homer declared that tools ought not be sold to a man who was too tight to buy equipment to maintain them. He said the emery wheel in his garage got more of a workout than any other power tool in the shop. He pointed out that if we had a grinder here we could keep our chisels sharp, our punches punching, our screwdriver bits square, and our bits so they would cut. He kept insisting that he could punch a hole quicker using a nail for a drill than I could using some of the bits we have in our collection. After listening to about twenty minutes of that kind of talk I promised to buy a grinder just

to shut him up; but I've got a sneaking suspicion he was right to a certain extent."

"Well, it certainly does me a lot of good to know that you were on the receiving end of a currying for once," Barney commented. "My only regret is that I was not here to listen to him pour it on."

"Never mind that," Mac told him. "The point I want you to keep in mind is that we can speed up our own work a lot if we will keep our eyes open for tools and techniques employed in other lines of service work that can be used to advantage in our shop."

"Hm-m-m-m," Barney said, thoughtfully stroking his chin, "you have something there; and I'm going to look into another form of repair and maintenance shop this very noon-hour."

"And where would that be?" Mac asked suspiciously.

"At that beauty shop on the next corner," Barney explained. "There's the cutest little redhead working in there who has been giving me the eye every day when I go to lunch; so today I'll just drop in and casually ask—"

Before he could finish the sentence Mac grabbed up the cardboard box in which the grinder had been and crushed it down over the boy's ears.

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CIVIL DEFENSE FILM

GENERAL Electric Company recently previewed a new film which evaluates the need for a good, efficient communications system in times of emergency.

Produced by the March of Time for G-E, the new film has been entitled, "A Voice Shall Be Heard".

Emphasizing the use of two-way radio in the community, the film graphically illustrates the operation of a centrally-controlled communications set-up and its coordination of mobile units. It first evaluates the part two-way radio plays in peacetime and then considers its requirements in an Atomic War. The film points out the need for this type of communication to be used when all other types of communications are inoperative.

The film unfolds the story of Syracuse under an atomic attack and portrayed the effectiveness of its civil defense measures. The destruction of Syracuse is depicted in such a manner that the viewer is able to foresee the possibility of this destruction in his own community.

The company is making this film available for local showings through many of its local offices. All that is required is that organizations contact the nearest office to schedule a showing of this film.

The following General Electric offices will be handling the film: 113 South Salina Street, Syracuse, New York, c/o H. M. Wales; 187 Spring Street, Atlanta 3, Georgia, c/o J. W. Bryant; 2511-13 Book Tower, Detroit 26, Michigan, c/o R. L. Casselberry; 106 W. Fourteenth St., Kansas City 6, Mo., c/o C. G. Turner; 901 Ross Avenue, Dallas 2, Texas, c/o J. W. Rondel; and 235 Montgomery St., San Francisco 6, California, c/o L. R. Sheeley.

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Audio Simplified
(*Continued from page 56*)

from the equivalent circuit of Fig. 4B. The circuit at middle frequencies is used for this calculation, and the gain at high and low frequencies obtained from the frequency response curve. The formula used for this calculation is:

$$Gain = -\mu \frac{R_L}{R_p + R_L}$$

where $R_L = (R_s R_o)/(R_s + R_o)$ is the total resistive load in the plate circuit, and the negative sign indicates that there is a 180° change of phase in a single tube amplifier. For pentodes a more convenient simplified formula is that

$$Gain = -G_m R_L$$

which is approximate but fairly accurate, because of the high plate resistance of pentodes.

(*b*) The *output impedance* of the tube is important when matching to attenuators, equalizers, transmission lines, and various other types of networks. It can be determined from the equivalent circuit of Fig. 3. The grid resistor generally does not exist in such circuits, and the tube circuit is considered to consist of the circuit elements up to this point, as shown in Fig. 3A. The output impedance at middle frequencies therefore appears as a resistance equal to the parallel combination of the plate load resistor and the tube plate resistance $(R_s R_o)/(R_p + R_o)$ in series through the coupling condenser, as shown in Fig. 3B.

(*c*) *Frequency response* can be predicted from the equivalent circuits at high and low frequencies shown in Fig. 4B, together with the curves of Fig. 4C. The coupling condenser and the following grid resistor give the low frequency response, while the total shunt capacity and the load resistance give the high frequency response. In determining the high frequency response, it is essential to take the Miller effect of the following tube into account.

(*d*) *Harmonic distortion* can be measured from the plate current characteristics of the tube as given in the tube handbook and from the load line. Considering the set of curves shown in Fig. 1A, it can be seen that if +1 volt is added to the grid voltage to change the bias to —1 volt, the voltage at the plate decreases by 35 volts, while if —1 volt is added to the grid voltage to change the bias to —3 volts, the voltage at the plate increases by 35 volts. Therefore for a +1 volt peak grid swing this amplifier is very linear and shows little distortion. However, when +2 volts is added to the grid voltage to change the bias to 0 volts, the plate voltage decreases by 70 volts, while it only increases by 55 volts when —2 volts is added to the grid voltage to change the bias to —4 volts. Therefore, for a +2 volt peak grid swing the amplifier is not linear, and harmonic distortion is introduced into the output

signal. This is illustrated graphically in Fig. 6. The maximum signal which can be applied to the grid of the amplifier is that voltage which will still produce linear changes in plate voltage as measured on the plate characteristic curves.

These formulas and curves contain sufficient information for the desigh of the voltage amplifier stage and for predicting accurately what will be its performance under practical operating conditions.

The complete voltage amplifier consists of a number of amplifier stages designed according to the procedure outlined before, and combined in such a manner as to meet the requirements of the system. In general, these requirements will be: (1) over-all gain, (2) input and output impedance, (3) frequency response, (4) input and output voltages, and (5) distortion. From the specific requirements of the system which is under consideration, it is possible to decide upon a good general tube lineup, choose the specific tube types to be used, the voltage gain of each stage, and the specific values of the circuit components to be used. The actual practical procedures involved in this process can best be illustrated by demonstrating their application to one or two typical amplifier designs.

Practical Circuits

As the simplest example of a voltage amplifier design, consider the requirements of a voltage amplifier to be used with a standard type of crystal phonograph pickup or a radio tuner. The input voltage to this amplifier will be in the neighborhood of 1 volt, and the output voltage should be at least 10 to 15 volts. Allowing for a reserve amplification of two or three times this amount so that the volume control will not have to be set full up, the required amplification has to be of the order of 30 to 50 times. The volume control is generally placed at the input of this amplifier to prevent overloading with high-level signals. This type of amplifier is used in most radio receivers, therefore a number of important points are illustrated in considering its design features.

The voltage amplifier circuit used in most radio receivers usually consists of a high-gain triode, such as the 6SQ7, in a circuit similar to that shown in Fig. 5A. The amplifier meets the requirements of gain, distortion, and output voltage but it cannot have good response at the higher audio frequencies. The reason for this can be readily understood by considering the Miller effect of the tube, especially when the volume control is set near the middle of its range. Specifically, for a tube gain of 40 the input capacity of the tube is about 85 $\mu\mu$fd. or higher; therefore with a 1.0 megohm volume control set halfway up, the response can be as much as 7 to 19 db down at 10,000 cps. The manufacturers of commercial radio receivers may consider this frequency response satisfactory for AM reception, but it is certainly not ac-

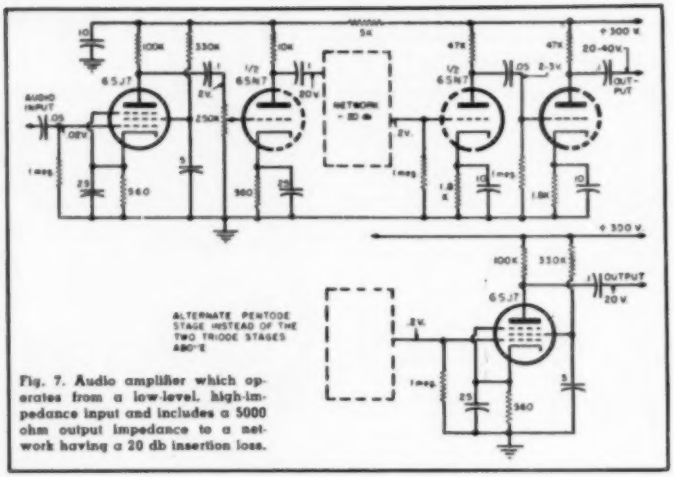


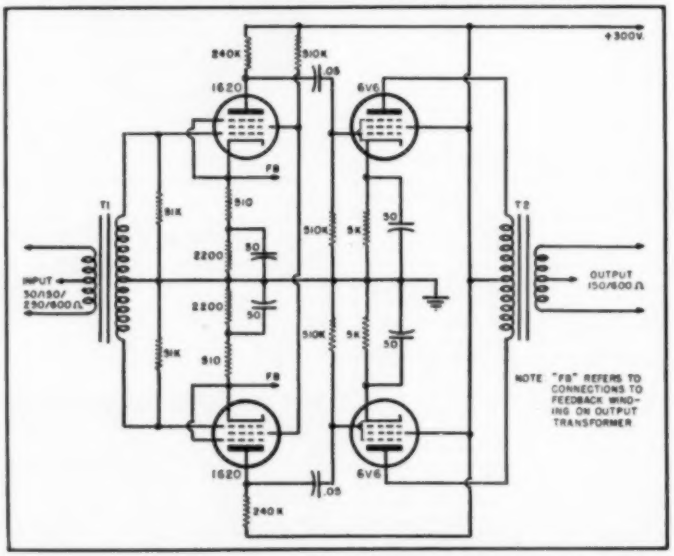
Fig. 7. Audio amplifier which operates from a low-level, high-impedance input and includes a 5000 ohm output impedance to a network having a 20 db insertion loss.

ceptable for high-quality sound reproduction.

A good frequency response in this voltage amplifier can be achieved by using a pentode instead of the high-gain triode stage. A typical pentode voltage amplifier which can be used for this purpose is shown in Fig. 5B. It is a standard pentode amplifier, designed from the tube plate current characteristics as described in this article, and has quite satisfactory gain, output voltage, distortion and frequency response characteristics.

In many applications, a more elaborate voltage amplifier than this is required. Often there may be additional gain and impedance matching requirements which must be met. The schematic of such an amplifier, which illustrates the methods of design to meet specific gain and impedance requirements, is shown in Fig. 7. This particular amplifier is designed to give full voltage output to the driver with an input of 0.02 volt at high impedance, and includes sufficient gain to compensate for a 20 db insertion loss network (such as a tone control or mixer circuit), which is fed from a 5000 ohm impedance. The first stage is a pentode, which has an amplification of 100 and whose output feeds into a 0.25 megohm volume control. Because of the Miller effect, the tube after the volume control is a low-gain triode. With

Fig. 8. Circuit of push-pull voltage amplifier with input and output transformers, which has extremely good characteristics suitable for broadcast applications.



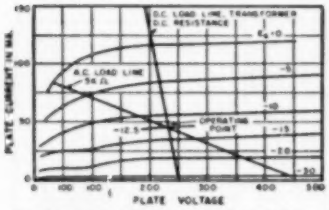


Fig. 9. Curves showing different load lines for d.c. and for a.c. signal when using a transformer in the plate circuit and method for determining operating conditions.

the 6J5 (or one-half 6SN7) and the circuit constants as shown, the input capacity of the tube is about 45 $\mu\mu$fd., which does not greatly affect the frequency response at any setting of the volume control. From the equivalent circuit, since the plate resistance of the tube is about 7000 ohms, the source impedance which is presented to the network is about 5000 ohms through the 1 μfd. coupling condenser. The output of this arbitrary network can then be amplified again either by a two-stage triode amplifier or by a single pentode, as shown in the diagram. The two triodes will have up to 6 db more gain, but either arrangement will have enough gain and supply adequate voltage to the driver. The approximate signal voltage levels at the various points in the circuit are indicated on the schematic diagram.

Some reproducing systems may require voltage amplifiers which are coupled through input and output transformers. The schematic in Fig. 8 shows the circuit of an amplifier of this type which has extremely good frequency response, noise and distortion characteristics, and which has been widely used for broadcast applications. This particular unit is a two-stage push-pull amplifier with a fixed gain of 50 db with various input and output impedances available. The amplifier stages are designed according to the principles described in this article, and illustrate an important point in the design of transformer-coupled stages. It should be noted that the impedance of a transformer is different for direct-current and for alternating-current signals, therefore the static operating point is determined by the d.c. resistance of the winding, while the signal gain is determined by the a.c. impedance reflected into the transformer primary. This is illustrated in the set of curves of Fig. 9. The amplifier shown in Fig. 8 and on page 54 has a frequency response of ± 1 db from 30-15,000 cycles, and has a 1 watt output at less than 0.5% distortion and up to 8 watts with slightly higher distortion. An amplifier with these characteristics can be extremely useful in setting up a sound reproducing system.

The next article in this series will discuss the application of negative feedback to amplifiers, cathode followers, the design of driver amplifiers and their coupling to the power amplifier.

(To be continued)

High-Gain Amplifier

(*Continued from page 59*)

model. This equalizing circuit, designed for use with tape operating at a speed of 7½ inches per second, is a bridged-T network, and its action is to suppress the middle frequencies, or, conversely, to boost the high and low end of the audio spectrum. The high boost is taken care of by the condenser C_{20} which has little reactance to the higher frequencies and hence conducts them directly to the grid of the following tube. Some of the middle frequencies are shunted to ground through the network R_{20} and C_{21}, but the value of C_{21} is such that it has high reactance to the very low frequencies and hence, they too, are amplified. The insertion of this equalizer does result in some loss of gain, but as previously stated, the amplifier has ample gain to take care of this loss nicely. If the builder wishes to use this circuit, it is inserted at the points *X*, *Y*, and *Z* on the schematic. It may be noted at this time, that this equalizer enhances the tone quality of the output of some types of phono pickups, and it seems to suppress the scratch frequencies to some extent, so it may be desirable to use it even if tape playback is not to be used. One other point should be mentioned regarding tape playback with this amplifier. Condenser C_1 is not needed in the circuit except for reproducing tape recordings. Its purpose is to form a resonant circuit with the playback head, giving a sharp high frequency boost, particularly at those frequencies which need boosting on tape playback. Its action does not have much effect on a crystal or dynamic microphone, so it is not necessary to switch it out of the circuit when a mike is used.

V_3 is a second 12SL7 which is used as a phase inverter. It will be noted that R_{16}, the bias resistor for this stage, is unbypassed. This can be bypassed if it is necessary for hum reduction, but somewhat better results can be expected from the phase inverter if this resistor is left unbypassed. Also, in connection with the phase inverter circuit, it should be noted that resistors R_{17} and R_{18} form a voltage divider which supplies the proper voltage to grid No. 2 of the phase inverter tube. Since the voltage delivered from the junction of R_{17} and R_{18} is dependent on the relative values of these resistors as well as upon the gain of the 12SL7, and since tubes and particularly resistors vary considerably, somewhat better results can be obtained from the phase inverter if the final value of R_{18} is chosen by measurements taken from the grids of the output tubes than if a nominal value of resistor is chosen. The measurements can very easily be made if a vacuum tube voltmeter or an oscilloscope is available. With a steady signal supplied to the amplifier, such as a tone from an audio oscillator, a voltage reading is taken at the grid of V_5, using either the vacuum tube voltmeter or

the oscilloscope. Then a similar reading is taken at the grid of V_a. If the voltage at V_a is lower than that of V_b, the value of R_m should be increased. Conversely, if the reading at the grid of V_a is higher than that at the grid of V_b, the value of R_m should be decreased. With a little experimenting, a very precise voltage balance can be achieved between the grids of the output tubes. However, if the builder does not have the necessary test equipment at his disposal, the values of the resistors given in the parts list will give good results.

At first glance it may appear that no inverse feedback is used in this amplifier. However, it will be noted that the cathode resistor, R_m, of the output tubes is unbypassed. This results in a small amount of degeneration which helps somewhat to reduce any hum and distortion which may be present. If a greater degree of feedback is desired, a ½ megohm resistor can be connected from the plate of V_a to the plate of V_b. However, this may necessitate a change in the value of R_m. The results obtained with the amplifier, as indicated in the schematic, were such that no additional feedback was deemed necessary, especially in view of the losses which would result.

50L6's were chosen for the output tubes because of their high power sensitivity and relatively high power output at low plate voltage. It will be noted that the maximum ratings for these tubes are indicated in tube manuals as 200 volts on the plate and 125 volts on the screen. The power supply previously described supplies very nearly the maximum voltage at full load and the proper screen voltage is obtained by using dropping resistor R_m. The output of these tubes at the maximum voltage ratings is in the neighborhood of 8 watts.

One precaution should always be taken with any equipment in which one side of the power line is connected to the chassis, *i.e.*, be sure that the chassis is not connected to the "hot" side of the power line. One method of assuring that the chassis will be connected to the ground side of the line is to use a chassis ground, actually connecting the chassis to a cold water pipe or other ground connection, and then to use just a single wire in the power cord, connected to just *one* of the prongs of the power plug. In this way, if the plug is inserted incorrectly, the set will be inoperative, but in no way will it be possible to make the chassis "hot." If this method is inconvenient, a small neon test lamp can be used to indicate whether or not the chassis is connected to the high side of the power line.

Operation of the completed amplifier should pose no special problems. The builder will find that within its power limits, this amplifier will perform as well as many higher-priced units.

REFERENCE

Fleming, Lawrence: "Controlling Hum in Audio Amplifiers," RADIO & TELEVISION NEWS, *Nov. 1950.*

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RADIO-TV Service Industry News

AS REPORTED BY THE

TELEVISION TECHNICIANS LECTURE BUREAU

NOW that the 1951 Holiday Season is over, the sixty-four dollar question is how quickly, where, and how much will the service industry benefit from the lifting of the TV station construction freeze which has been freely predicted to happen in January?

Fall Service Business Disappointing

The Fall upswing of service business in practically all TV areas did not reach the levels that had been hoped for. Each year the Fall rise in installation and service volume in TV areas has been less pronounced than the previous year. This indicates that the "boom type" of business is definitely a thing of the past in those areas.

Hopes for a boom converting receivers for color TV died with the freeze clamped on color by the WPB. The result is that most progressive service businessmen are critically reviewing their entire operating plans to determine what type of service selling programs they need to maintain an adequate volume of business under these new norms. And u.h.f. does not promise too much in the way of increased service volume in major TV areas.

A "task force" of the Radio-Television Manufacturers Association has been making a study of the television industry to determine the effect on the national economy and the mobilization program of the lifting or continuing of the TV "freeze" on station construction. Its purpose is to determine the effect on materials and manpower if the freeze is lifted and the effect on the television industry if construction of additional TV stations is not permitted.

There has been some concern that the lifting of the freeze would start a rush to get many new television stations on the air and create a demand for steel, copper, and other materials. However, many industry representatives believe there are sufficient transmitters now under construction or already completed and held in warehouses to satisfy the demand through 1952.

Also, there has been considerable concern in the industry that if the Federal Communications Commission does not lift the "freeze," the electronic industry may suffer from a period of depression and unemployment in spite of heavy military electronic contracts. This is further evidenced in statements previously quoted in this department to the effect that even at its peak the defense program will be using only about twenty per-cent of the productive capacity of the electronics industry.

A capacity crowd jams St. Joseph's auditorium to hear Edward M. Noll of the Lecture Bureau speak on u.h.f. television and the alignment of TV front ends. The lecture, which included a demonstration of the correct procedure for aligning TV front ends, was sponsored by Albert Steinberg & Co., Philadelphia parts distributing company.

Since the dominant factor in electronics production is now television and the movement of new TV receivers into the hands of new owners has been sluggish for more than a year, the immediate answer to the industry's production problem is to tap new markets.

Where Will New Stations Be Built?

Since the defense program requirements for steel, copper, and other materials probably will not permit an all-out drive to produce new telecasting station equipment, the equipment available for new stations undoubtedly will be allocated to areas that do not have television now or where the marketing area is inadequately covered by present facilities. This can be accomplished by the Federal Communications Commission in granting priority to station CP's in non-televised areas.

The industry would accomplish two important gains through the allocation of available new station equipment to non-television areas. First, it will immediately open up new markets for television receivers and second, it will provide new televiewing audiences.

On the basis of this analysis the first effects of the lifting of the station construction freeze on the independent service industry will be in currently non-television areas. Just how much of a "boom" will develop in those areas is highly problematical.

When television was officially launched after the war we were in the midst of a post-war boom with the entire nation in the mood to "buy" after living through the purchasing restrictions of the war-time economy. Television was the great, new, postwar development; a fascinating mystery; an intriguing novelty. Television receivers were easy to sell in this non-critical market because the children's programs absorbed the attention and interest of the small fry and they provided ringside seats to all sports events. No one complained much about picture quality.

Set manufacturers, distributors, and dealers concentrating on sales did not want to bother with the problems of installation and service so this immense dollar-volume business was freely given to service operators who went after it. With an antenna installation and a service contract involved in practically every TV receiver sale this phase of television was a tremendous business bonanza—for a while.

New television areas will not experience this sort of a boom, particularly in installation and service of TV receivers. An entirely new set of conditions prevails today that will have a marked effect on the speed of the growth of television in newly TV-served areas.

The novelty of television has worn off. The average user considers his television receiver as just another modern device and it must compete with radio, the movies, and social activities for his attention and interest. Add to that the pressures of the defense program, higher taxes, and a ris-

ing cost of living and you end up with today's average consumer who is a critical buyer.

Sure, there will be a good spot market for television receivers in each new area that opens coupled with the need for the associated installation, adjustment, and service. But service businessmen in new TV areas should expand their businesses cautiously. Adequate finances should be available to make the necessary capital investments for the business of installing and servicing TV receivers. Many TV service contractors in the early TV areas went broke simply because they were badly under-financed and attempted to finance the necessary trucks, test equipment, parts, tubes and supplies stocks, etc., out of income. This looked easy when they were getting all of the installation and service contracts they could handle. But when payrolls and general operating expenses had to be met month after month in servicing those contracts for twelve months they found there just wasn't enough income to go around. The seeds of success or failure are usually sown during the first six months of a TV service business' operation so it is vitally important to get started on a sound business basis.

An interesting article on "Financing a Service Business" is available to readers of this department. You may obtain a copy by writing to Service News Editor, RADIO & TELEVISION NEWS, 366 Madison Ave., New York 17, N. Y.

The most serious problem in new TV areas will be the lack of trained, competent, installation and service technicians. This is already a very serious problem in all present television areas so there is little hope for drawing experienced television service technicians from those sections to work in the new TV areas. This shortage of qualified personnel will be a serious obstacle to the growth of independent service businesses that must depend on the local labor pool for skilled TV technicians.

The RTMA program which will start with service training programs for technicians in the nation's trade and vocational schools, is one that should be actively and aggressively supported by all segments of the television industry and particularly by independent service business operators. This program, which is being developed under the direction of E. W. Merriam, former service manager of the *Allen B. DuMont Laboratories, Inc.*, and now service manager for RTMA, is especially designed to expand the pool of trained technicians available for field service work. It is of special importance to independent service businessmen whose businesses are not large enough to support internal technician training programs of their own.

U.H.F. in Major TV Areas

It is highly questionable whether u.h.f. will cause any appreciable increase in service business volume in areas that are now being served by two or more stations. If manufactur-

ers' claims about the ease and simplicity of adding u.h.f. channel reception to their current model receivers are valid, there will be very little additional income available from u.h.f. conversions. An outdoor antenna may be necessary on some sets that are now receiving v.h.f. satisfactorily with indoor or built-in antennas but the customer himself will probably have to be sold on whether the programs he would receive on u.h.f. are enough better than his v.h.f. programs to justify the outlay for the conversion and antenna installation.

The pattern of service in major TV areas seems to be pointing toward a necessity for service-selling programs that will keep the consumer conscious of the fact that his set needs maintenance attention for top picture quality just as the automobile owner has been sold on car maintenance as an insurance for dependable service and for avoiding expensive overhaul jobs. The TV set owner is using an instrument about which he knows practically nothing and it is a service industry responsibility to keep him informed about what he should have done in the way of maintenance to get the most pleasure and satisfaction out of that instrument.

Another thing that is being called constantly to the attention of editors of this department is the general lack of interest or courtesy when a set owner phones the average TV service shop about service on his receiver. Since we have heard these complaints from set owners in practically every major center in the country it must be a universal failing of the independent servicing industry.

Your business phone is one of your most important service sales tools. When a customer calls you for service you can either make him a strong booster for your business or you can lose him completely as a customer—in a hurry. Your customer is your boss and even though he may act a little exasperated when he phones in for service he is not going to like you if you answer him in kind. Remember always that a "soft answer turneth away wrath," apply it in all of your dealings with your customers and you will do a good job of building customer good-will for yourself and for your business.

Parts Warranty Sales Vex Service Industry

The most exasperating and expensive problem that TV receiver manufacturers have put in the laps of the service industry has been that of the sale of 12-month parts warranty contracts tied-in with the purchase price of the receivers. Executives of the various service associations such as TISA of Chicago and TCA in Philadelphia have pounded on this subject for months trying to bring about an abatement of the practices which they say are brought about by the 12-month parts warranty sales.

The National Radio & Appliance

Dealers Association through the efforts of its president, Mort Farr of Upper Darby, Pa., has done much to bring the dangers and inequities of this practice to the attention of responsible manufacturers. It is now generally felt that steps will soon be taken to correct this situation that has been so costly to servicing contractors and dealers.

Plus Service Income

There is not a home in which you are called to service a radio or television receiver that does not need some other products or accessories that you handle regularly. Such items will add to your "per call" income—and profit. A few of these are:

(1) Dry batteries for portable radios and flashlights
(2) Phonograph needles
(3) Phono replacement cartridges
(4) Wire and tape for home recorders

Usually when you mention batteries for flashlights you receive an appreciative response from the customer because they find the batteries are usually dead when they occasionally try to use the flashlight that is kept for emergencies. This is also true of battery-operated portable radios, thousands of which rest on closet shelves while someone in the family tries to remember to get some batteries.

More than nine million battery-operated portables have been sold since the end of the war and current sales are at the rate of about two million sets per year. This represents a tremendous market for batteries and one which the service shop operator can handle profitably and which can be helpful in getting other service business. —30—

International Short-Wave

(*Continued from page* 125)

kw. rig that tested some months ago. Verified from Philips Peruana, Box 1841, Lima, Peru. (Russell, Calif.)

Lima, 15.105, *Radio El Sol*, noted around 1815; identifies plainly 1830 with slogan. (Russell, Calif.)

Philippines—Russell, Calif., flashes that he has picked up the *new* 25-m. outlet, DZH9, of the Far East Broadcasting Co., Manila, on 11.850A, in parallel with other outlets of this broadcaster on regular schedule. Russell says DZH7 has apparently moved from *measured* 9.7345 to *measured* 9.7286.

DHY2, 6.14, signs off around 0959; announces also for DYRC, 1040 kc. (Gay, Calif.) *Radio Free Asia*, 6.110, Manila, still noted signing off 1000. (Dale, Calif.)

Poland—Radio Warsaw still noted signing off *English* program 0100 on 7.205. (Hoffman, N. Y.) Excellent on this channel opening in *English* 1700. (Mast, N. Y.)

Portugal—Radio Sweden says Lisbon can be heard mornings (*EST*) over 11.960 but changes to 11.995A at 1230. *Measured* by Ferguson, N. C., as 11.960 at 0945. Pearce, England, reports Lis-

bon on 11.995 to 1530 and 1600-1800 (parallel 9.745); on 11.962 at 1030; he also notes Lisbon at 15.130 at 1015 with music.

Radio Free Europe relay from Lisbon noted on 9.605A with interval melody on chimes when tuned 1903, then left the air. (Bellington, N. Y.) Heard in Czech 1145 and at 1200 gave call "Radio Volna Sobodna Europa"; noted another day signing on 1100. (Pearce, England)

Portuguese Guinea—Bissau, 5.84A, is still signing off 1800 with "A Portuguesa." Has usual heterodyne QRM. (Bellington, N. Y.)

Portuguese India—Radio Goa, 9.610, has an *English* broadcast at 100 called "Catholic Hour," which features devotions to the Sacred Heart conducted by Jesuit Fathers and directed by priests from the "Legion of John Bosco." (*Short Wave News*, London)

Sao Tome—CR5SB, 17.677, noted recently 0702 in Portuguese; signal faded greatly by 0720. (Ferguson, N. C.) This one is scheduled 0700-0800 on Sundays and Thursdays *only*.

Saudi-Arabia—Djeddah, 11.952, noted with Arabic program 1200-1350; sometimes closes 1330 or 1315; calls "Houna Mecca" pronounced ("Mukka"); has interval signal on flute playing 8 notes —before opening at 1200. (Ridgeway, South Africa) Also heard on 11.85 (jammed) and 5.975 at that time. (Pearce, England) Still signs on 2300 and runs to approximately 2345 daily, heard on 5.975A, 11.85, 11.95. (Bellington, N. Y.)

Sierra Leone—At present there is no regular broadcasting from this country but experimental broadcasts are carried out irregularly from Freetown over a 300 watt transmitter operating on 9.630. (*WRH Bulletin*)

Southern Rhodesia—Salisbury, 3.320, noted with organ recordings 1325, call 1330. (Pearce, England) Salisbury is definitely back on 9.50 now that *Springbok Radio*, Johannesburg, South Africa, is using 9.60 at 0300 to approximately 0700. (Ridgeway, South Africa)

Spain—Madrid, *measured* 15.627, noted opening program in Spanish to Canary Islands 1146, ending 1157. (Ferguson, N. C.)

Sweden—According to a *WRH Bulletin*, from January 15 the *new* 100 kw. transmitters at Horby will be on the air on this schedule—1900-2145 on 6.065 to USA (East Coast); 2200-2245 on 9.535 to East Africa; 2300-2345 on 9.620 to India, Indonesia, and on 9.535 to USA (West Coast); 0000-0100 on 9.535 to South Africa; 0600-0645 on 21.580 to South America; 0700-0745 on 11.880 to USA (East Coast); 0800-0845 on 9.535 to Far East, Pacific; 0900-1100 on 9.535 to India, Indonesia; 1200-1245 on 9.535 to East Africa; 1300-1345 on 9.535 to South Africa; 1600-1700 on 9.535 to USA (West Coast) and 1800-2100 on 6.095 to South America. Uni-directional transmissions to Europe (relay of Swedish Home Service) will be radiated at 0000-0400 on 6.065; 0400-1200 on 11.705; 1200-1800 on 6.065, and 1400-1545 on 6.095.

Switzerland—*Winter* schedules of Berne are (to April 30)—*To North America*—2030-2215, HER3, 6.165, HEI3, 7.210, HER4, 9.535, HEU3, 9.665, HER5, 11.865; 2215-2300, HER3, 6.165, HI3, 7.210, HER4, 9.535, HEU3, 9.665, and HER5, 11.865. *To South Africa*—0945-1130, HER6, 15.305. *To Eastern Australia and New Zealand*—0215-0400, HER5, 11.865, HER6, 15.305, HER7, 17.784. *To Western Australia and the Far East*—0400-0445, HER5, 11.865, HER6, 15.305, HER7, 17.784. *To South-East Asia and Japan*—To Feb. 29, 0745-0930, HER5, 11.865, HER6, 15.305, HER7, 17.784; from March 1-April 30, 0745-0930, HEU3, 9.665, HER5, 11.865, HER7, 17.784. *To India and Pakistan*—To Feb. 29, 0945-1130, HER5, 11.865, HEU3, 9.665; from March 1-April 30, 0945-1130, HER5, 11.865, HER7, 17.784. *To The Middle East*—HEU3, 9.665, HER2, 6.055. *To Spain and Portugal*—1545-1600 in Portuguese, 1600-1715 in Spanish, HER2, 6.055, HEU3, 9.665. *To Latin America*—In Portuguese 1800-1830, in Spanish 1830-2000, HEI3, 7.210, HEU3, 9.665, HER4, 9.535, HER5, 11.865, HEI5, 11.715. *To Europe*—0015-0115, 0500-0830, 1000-1730, HER3, 6.165, HER4, 9.535. *To South Africa*—0015-0140, HER6, 15.305; 0500-0730, HER8, 21.520; 1130-1730, HER6, 15.305.

United Nations Radio, 6.672, noted with news 1330; news in French 1345. (Pearce, England)

Taiwan—When this was compiled, Taipeh, 7.133A and 11.730A, had changed time of *English* news from 0630 to 0730 (winter schedule). (Rosenauer, Calif.) Also noted by Stark, Texas, and by your editor in West Virginia.

The *N.Z. DX Times* reports a *new* station of the Chinese Broadcasting Corporation heard on 10.425 at 0600; call is either BED26 or BED36. Frequency varies greatly.

"The Voice of Free China," Taipeh, is now on the air daily with a program directed to Europe 1400-1600 over BED4, 11.800; at 1400 in Russian; 1420 *English;* 1450 French; 1520 Arabic, and 1540 Mandarin. (*WRH Bulletin*) *Radio Australia* reports the 11.800 outlet noted 1500 and with identification in *English* 1700 followed by a program of Chinese music; signal strength and quality vary from poor to good.

The 15.235 outlet noted 0005 with native music. (Winch, Calif.) The *English* transmission on 6.095 now is 0630-0700 but does not appear to be daily. (Rosenauer, Calif.) BED26, 10.080A, noted 0545 with Chinese news and popular music; BED32, 7.010, noted 0645 with Chinese-*English* lesson; BEC22 (?), 9.775, heard 0430 with Chinese news. (Sanderson, Australia)

Tangiers—At the time this was compiled, Pearce, England, flashed that he had not heard Pan-American Radio on 7.525 lately; moved?

Radio Africa noted on 7.125 at 1630 with call in English. (Pearce, England)

Thailand—Bankok, 11.910, noted 0510 with news and weather reports; on 6.240 at 0600 with news, music. (Sanderson, Australia)

Trans-Jordan — "The Hashemite Jordan Broadcasting Station," Ramallah, is operating on 7.030 with 500 watts 0045-0130, 0600-0730, 1000-1500; *English* 0600-0630, 1000-1100. (Bluman, Israel, via *WRH Bulletin*)

Trinidad — VP4RD, 9.625, Port-of-Spain, noted at fair level 1930-2000 and later; announces "This is Radio Trinidad;" severe QRM from XEBT, Mexico. (Hoogerheide, Wisc.)

Turkey—Radio Ankara has *English* now daily for British Isles-Europe 1600-1645 over TAP, 9.465, and TAS, 7.285; noted signing on in Italian 1415 on these channels recently. (Pearce, England) I recently noted TAU, 15.160, in English at 0835; seemed to be calling Germany with a special broadcast.

Uruguay—Radio El Espectador lists its schedule on 11.835 as 0600-2200. (Radio Sweden)

USI—The Indonesian on 11.080 appears to be parallel mornings with Makassar, Celebes, on 9.550. (Stark, Texas) The 11.080 outlet noted around 0800. (Dilg, Calif.) The Indonesian on 7.165A has been identified by Graham Hutchins, DX Editor of *Radio Australia* as an Indonesian Air Force station located at or near Djakarta; for a while was heard regularly mornings but had not been noted for some days (by either Stark, Texas, or Dilg, Calif.) when this was written.

Djakarta, 4.94, noted with French program 1045, strong signal, woman announcer; fades 1115; possibly YDP? (Ridgeway, South Africa) Rosenauer, Calif., reports Djakarta heard recently in parallel over 6.045 and 7.270 at 0900-0930, best on 6.045.

YDC, 15.15, still noted signing on 1400 with *English* for Europe. (Pearce, England)

"The Voice of Indonesia," Djakarta, has an *English* language program for South Asia 0930-1030 on 15.150, 11.770, 4.915. (Radio Sweden) YDF, 6.045, Djakarta, noted in native program when tuned 0547; fair level with slight heterodyne QRM. (Bellington, N. Y.)

USSR—Khabarovsk is noted on 6.07 at 0301 in language; fair level in Calif. (Winch) Moscow noted opening 0102 on 6.000 in French session; parallel on 7.34. (Bellington, N. Y.) *Radio Tashkent*, 6.825, noted with *English* 1000 and 1115-1130. (Pearce, England) A Soviet outlet is noted around 0300-0500 on approximately 15.400. (Osburn, Alaska)

Vatican—HVJ has *English* news 1000 on 15.120, 11.740, 9.646. (*Short Wave News*, London)

Venezuela—Caracas, 4.9227, noted in native program 2200. (Russell, Calif.)

Yugoslavia—Radio Belgrade, 6.100, heard with call "Radio Yugoslavia" 1630, followed by news in what sounds like Russian; terrific jamming, still noted 1650. (Pearce, England)

* * *

Press Time Flashes

The Yugoslav Emigrant Radio Station (clandestine) seems to be scheduled 0030-0050A on 6.887 and 7.444 (listed) and in second period 0115-0200; during first session only a man talks,

presumably in a Slavonic tongue; in second period both a man and woman are heard; cannot find on 9.14 at that time. Also noted on 6.887 afternoons or later. (Bellington, N. Y.; Harris, Mass.; Machwart, Mich.) Bellington also has noted the 6.887 outlet in parallel with one on 6.28 at 1745.

Radio America, 9.405, Lima, Peru, announces *English* for *every day* at 1200 and *Sundays* at 2100. (Stark, Texas)

Nepal Radio, 7.100, Kathmandu, Nepal, verified for Dilg, Calif. Gave schedule of 2150-2320, 0320-0450, 0820-0950; *English* news is 0845-0850. Station opened last April. Hopes to expand. Said Kathmandu time is 10 minutes *ahead* of Indian Standard Time which makes it 10 hours and 45 minutes *ahead* of *EST*.

Bellington reports Greenland on approximately 7.580 from around 1730 to 1845 when closes with Danish Anthem; man announcer.

Radio Sweden says Hamburg, Germany, has two *new* transmitters on 17.815 and 17.815, respectively, in parallel with 7.290, 11.795.

Pakistan has changed its time—West Pakistan (Karachi) is now 9½ hours *ahead* of *EST*, while East Pakistan (Dacca) is 11 hours ahead of *EST*. (*WRH Bulletin*)

RIAS, 6.005, Berlin, Germany, is heard regularly in England with powerful signal; often features dance music around 1330; QRA is RIAS, Berlin-Schoneberg, Kufsteiner Strasse 69, Berlin, Germany. *Radio Andorra*, 5.990, noted around 0700 with Latin-American music, announcements in French and Spanish. *Radio Mediterraneo*, 7.037, Valencia, Spain, heard with strong signal prior to closedown 1830. (Catch, England)

The *English* transmissions from Lourenco Marques, Mozambique, are now 2300-0200 on 11.762, 4.911; 0200-0500 on 11.762, 7.305; 0500-0800 on 11.762, 9.732, 7.305; 0800-1200 on 11.762, 7.305; 1200-1600 on 4.911, 3.490. (*WRH Bulletin*)

The Swiss Broadcasting Corporation by this time should have a DX session in *English* in its various transmissions (probably on the first Tuesday and/or Wednesday of each month); I hope to have details soon.

Australian DX-ers Calling is now Sundays 0030 on 15.200, 21.540; repeated 0902 on 9.580, 11.810, 15.320; no longer heard 0200.

"The Voice of Free China" at Taipeh, Taiwan, is now radiating these Overseas Services—2300-0200 to USA on 15.235 (BED3) and 11.735 (BED6), *English* to 0000, Chinese slow-speed news from 0100; 0530-1100 on 7.130A (BED7) and 11.735 (BED6), to 0800 to Japan, Korea, and South East Asia, with news 0730, news in French 0740-0750, and from 0800 to Chinese mainland; from 1100 to 1230 has dictation news in Chinese to China and South East Asia on 6.095 (BED9), 7.130A (BED7), and 11.735 (BED6). (*WRH Bulletin*)

WRH says *Radio Free Europe* is now operating on six s.w. channels—6.020,

6.095 at 2300-1900; 6.130, 7.165, 7.300 at 1000-1900; and 9.607 at 1200-1900.

Paris noted on 21.740 to 1045 sign-off; on 11.700 at 1615 in French. (Leary, Ind.)

Radio Peking now has news 0400 instead of former 0430. (Alcock, Ky.) Confirmed by Cushen, N. Z., who lists frequencies at that time as 6.100, 10.260, 11.690, 15.060, 15.170 (these vary somewhat). (Radio Australia)

The Indonesian Air Force station, 7.163A, believed located at or near Djakarta, now signs off 0630 instead of former 0845. (Rosenauer, Calif.) Confirmed by Cushen, N. Z. (Radio Australia)

Dilg, Calif., hears Thailand on 7.105A, in dual with Bangkok, 6.240, around 0900 in native.

Russell, Calif., notes AFRS, Tokyo, on measured 9.6054 and 11.825 with news 0100.

Ridgeway, South Africa, flashes that Salisbury, 9.50, Southern Rhodesia, now closes 1315 on 9.60 after which continues on 3.320; Luanda, Angola, on 9.64 at 1300 parallel with 7.148; *Radio Tananarive*, 7.37 and 9.695, Madagascar, with Malgache programs, opening 0905 after interval signal of Malgache guitar.

Ferguson, N. C., recently noted Lisbon on 15.020 with a program for Chile to after 2017; Indo-China on 9.740 around 0530 to after 0630; HJCQ, 11.680, Bogota, Colombia, opening 0700; Baghdad's listed 11.724 measured on 11.726 at 2257; Moscow 1233 with news on 15.360.

Gerran, N. Y., reports YVQI, 3.450, Barcelona, Venezuela, at 2116 through heavy QRM; YNHB, 6.550, Managua, Nicaragua, around 2048 with music; YNDG, 7.660, at 2100 in clear with music; AIR on 11.85 with news 1930 (is parallel on 15.29); Paris, 9.680, signing on 1900 with "La Marseillaise."

Bellington, New York, flashes that he recently heard Athens on 7.300 with news 0000; that Greenland is again audible on 7.575 around 1746 tune-in to after 1800, mostly music, and that Lagos, Nigeria, 7.255, is sometimes audible around 0001.

Short Wave News, London, says *Radio Eireann* hopes to start broadcasting over the *new* high-powered station within six months now that the new Government "has given the green light. *Vatican Radio* will probably be one of the first users of the new station."

An attractive QSL card has been received from the *new* Spanish station at Cadiz, "Radio Juventud, Escuela No. 17 del Frente de Juventudes," which translates "Radio Youth, School No. 17 of the Youth Front." The frequency is 7.200 and the QRA is "Radio Juventud." Buenos Aires 4, Cadiz, Spain. (*Short Wave News*, London) This one noted signing off 1800A. (Bellington, N. Y.)

Canada's International Service schedules are — *European Service* — 0850-1130, CKNC, CKCX; 1130-1330, CKNC, CKCS; 1330-1345, CKCS; 1345-1400, CKCS, CHOL; 1400-1420, CHOL; 1420-1545, CHOL, CKLO; 1545-1600,

CKLO; 1600-1830, CKLO, CKRZ. *Australasian Service*—2300-2335 (*except* Sat., Sun.), commentaries from the United Nations, CHOL, CKLO; 0340-0450 (Sun., Wed. *only*), English sessions, CHOL, CKLO. *Caribbean and Latin American Service*—1850-2240, CHOL, CKLO; English 2105-2135. Channels are CKNC, 17.82; CKCS, 15.32; CKCX, 15.19; CHOL, 11.72; CKLO, 9.63; CKRZ, 6.06.

The Malayan Station on 6.135, reported by Rosenauer, Calif., earlier as probably Kuala Lumpur, has been identified by Graham Hutchins, *Radio Australia*, as *Radio Malaya*, Singapore; noted mornings.

Bangkok, 6.240, has *English*-Thai session 0500-0625 now; around 0624 gives preview of next day's program. (Radio Australia)

DYH4, 6.055, Dumagete City, Philippines, noted in Calif. 0800-0830 sign-off in *English*; fair. (Rosenauer)

Rome, 17.800, noted 1445-1500 in *English* for South Africa. (Alcock, Ky.)

Teheran has informed Harris, Mass., it operates with 20 kw. on 15.100 with German 1330; *English* 1345 and 1500; 1400 Persian program for Iranians abroad; 1445 French; 1515 in Russian; signs 1530 with Iranian National Anthem; *English* may *not* be daily according to schedule furnished.

OAX4Z, 5.8873 (measured), Peru, noted signing off 2345 after anthem. (Russell, Calif.)

PRF6, 4.895, Manaos, Brazil, noted 2346-0325 and later; announces "Radio Bare, en Manaos, Amazonas, Brasil." Noted another night leaving the air 0100. HI1Z, 6.112, Trujillo, Dominican Republic, noted signing off after anthem 2301. HC2FB, Guayaquil, Ecuador, noted on *new* channel of 6.118 after HI1Z leaves the air, signs 0058. (Machwart, Mich.)

Copenhagen is now scheduled to North America daily 2030-2130, 2200-2300 on 9.520.

ZM2AP, Apia, Western Samoa, operated by the New Zealand Broadcasting Service, should be testing soon on 3.410 and 6.040; schedule should be 0030-0330 (Mon. 0100-0230), 1500-1600. (Cushen, N. Z.)

Radio Pakistan, 11.675, has good signal opening 0830 with program for Burma. (Ferguson, N. C.; Boord) Carries news 1015.

Radio Dalat, Indo-China, is broadcasting a daily program in Vietnamese on 7.265, 1 kw., at 0515-0630; a program in French is on the air each Saturday 0630-0700. *Radio Hanoi* operates on 6.165, 1 kw., at 1830-1930, 2300-0030, 0500-0830 in Vietnamese, French, *English*, and Chinese; news in French 1805-1820, 2345-2400, 0730-0755; news in *English* 0530-0545. (*WRH Bulletin*)

* * *

Acknowledgement

Thanks for all the splendid reports during 1951, fellows! May 1952 bring you much worth-while DX! Send reports to Kenneth R. Boord, 948 Stewartstown Road, Morgantown, West Virginia, USA. . . . . KRB

Technical BOOKS

"TELEVISION INTERFERENCE" by Philip S. Rand, et al. Published by the Laboratory of Advanced Research, *Remington Rand*, South Norwalk, Conn. 80 pages. Will be sent to any ham without charge upon postcard request to the company.

This paper bound booklet contains seventeen articles on the subject of TVI reprinted from several well-known technical magazines in the radio field.

The articles cover a variety of topics ranging from curing r.f. heater television interference, to "TVI-proofing" the 10 meter transmitter, and other pertinent information.

Most of the articles contained in this reprint were originally prepared by Mr. Rand although one of the articles was authored by George Grammer and another by A. David Middelton. All of the material is of vital interest to the ham and we would like to suggest that amateurs get their requests in early for copies of this booklet.

Reprints from RADIO & TELEVISION NEWS, *Modern Plastics*, *QST*, *Electrical Manufacturing*, *CQ*, and *Electronics* have been included.

* * *

"HIGH FREQUENCY TRANSMISSION LINES" by Willis Jackson. Published by *John Wiley & Sons, Inc.*, New York. 149 pages. Price $1.75.

This small handbook contains much practical information of interest to those working with the high frequencies.

In six concise chapters the author covers such topics as the applications of transmission lines at very high frequencies, the basic equations for transmission lines propagating in the principal mode, the propagation characteristics of lines, the behavior of terminated lines, resonant lines, and impedance transformation and the use of the circle diagram technique. Two appendices provide data on the construction of a Cartesian grid diagram and on the construction of the polar form of diagram. A supplementary bibliography completes the work.

Treatment of the subject is largely mathematical so a working knowledge of advanced algebra and calculus is a "must". The author's style is lucid and if the reader can hurdle the barrier of the formulas, he should derive considerable benefit from this text. —30—

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